Kajakai and Arghandab Reservoirs, water surfaces consist mostly of rivers, streams, canals, and drains. Evaporation of water from small lateral ditches and farm ditches will generally be reflected in the evapo-transpiration values computed for consumptive use.

Since the evaporation from large bodies of water is seldom if ever equal to that measured by the pan method, pan coefficients of 0.5 to 0.7 are often used to estimate total water surface evaporation.

The average annual surface water evaporation in the Desert Plains and Desert Upland Resource Areas from the rivers, streams, canals, and drains is estimated at 338,000 Ml (274,000 ac-ft). Evaporation in the Mountains Resource Area from rivers and streams is estimated at 105,000 Ml (85,000 ac-ft). The average annual evaporation from Kajakai Reservoir is estimated at 143,100 Ml (116,000 ac-ft)[22/] and from Arghandab Reservoir at 40,700 Ml (33,000 ac-ft).[29/]

C. Irrigation - Total water consumption in the Helmand River Basin by crops which can be irrigated from surface sources is estimated to be 1,357,400 Ml (1,100,000 ac-ft) annually. This is based on a consumptive use or crop requirement of 0.8 m (2.6 ft) in the Desert Upland Resource Area and 0.9 m (2.9 ft) in the Desert Plains Resource Area. Past studies have indicated slightly smaller values than these.[14,28,29/] A change in the effective rainfall due to a longer period of record along with changes

in cropping patterns have resulted in an increase in water requirements. Crop consumptive use was not computed for the Mountains Resource Area since very little cropland exists in this area and even less is known about cropping patterns. The total water consumption by irrigated crops is computed by multiplying the unit consumptive use by the total irrigated cropland in each of these Resource areas. Total irrigated cropland is discussed in Chapter 5.

Total water diverted from surface sources for irrigation is estimated to be 3,948,800 Ml (3,200,000 ac-ft). This is based on a compilation of various diversion records throughout the basin. Good diversion records are available for the project areas, which include the Boghra Canal, the Darweshan Canal, and the South Canal which serves the Central Arghandab and lower Tarnak areas. Fairly good diversion records are available for the Seraj Canal, and only scattered and random measurements are available for other diversions.[11/] These are summarized in Table 4-6.

This means that there is a total surface water diversion of 2.4 m (8.0 ft) for the irrigated land in the Helmand River Basin. There is less water diverted per unit of land in the Arghandab or Kandahar area than in the Marja, Nad-i-Ali, Shamalan, and Darweshan areas. This indicates that in the Desert Upland Resource Area the diversion is 2.1 m (6.8 ft)

and in the Desert Plains Resource Area the diversion is 2.7 m (9.0 ft).

The estimated overall irrigation efficiency from river diversion to crop root zone is 32 percent in the Desert Plains Resource Area and 38 percent in the Desert Upland Resource Area. In the Desert Plains Resource Area the on-farm efficiency is estimated to be 46 percent and the canal delivery and distribution efficiency is estimated to be 70 percent. In the Desert Upland Resource Area the on-farm efficiency is estimated to be 50 percent and the canal efficiency is estimated to be 76 percent.

Part of the difference in the on-farm irrigation efficiency is due to the availability of water. Surface water is more readily available in project areas in the Desert Plains Resource Area than in the Desert Upland Resource Area. Most of the land in the Desert Plains Resource Area is served by canals that divert water from the Helmand River which, as pointed out in a previous section, has an adequate water supply and large diversion dams and canal systems by which water can readily be diverted to the irrigated cropland. However, irrigated cropland in the Desert Upland Resource Area is served by canals from the Arghandab River which has experienced water shortage; and by canals which divert water in the traditional manner from fluctuating streams where excess water is difficult to divert.

Part of the difference in the canal delivery and distribution efficiency is also due to the difficulty of obtaining water. Where water is hard to obtain, more care is taken not to waste it while transporting it to farms. Some of the canals in the Desert Plains Resource Area are constructed through pockets of gypsum and layers of fracture conglomerate which permit greater than normal seepage losses. Evaporation is also greater in the Desert Plains Resource Area. Also, a greater percentage of the project canals are lined in the Desert Upland Resource Area than elsewhere.

Table 4-6 Surface Water Diversions to Irrigated Cropland, Helmand River Basin, 1974 11/

Canal	Amount of Water Diverted	
	Megaliters	Acre-feet
Helmand River		
Seraj Canal	225,820	183,000
Boghra Canal	1, 301,250	1,054,500
Darweshan Canal	578,000	468,400
Other Canals	599,850	486,100
Sub-Total	2, 704,920	2,192.000
Arghandab River		
South Canal	402,650	326,300
Other Canals	494,340	400,600
Sub-Total	896,990	726,900
Other Rivers		
All Canals	346,880	281,100
Basin Total	3,948,790	3,200,000

D. Ground Water Recharge - Recharge to the ground water occurs each year as a result of precipitation. The total water produced by precipitation for the watershed is about 30,850,000 Ml (25,000,000 ac-ft). Based on estimates made in previous studies, the amount of precipitation which can percolate to the ground water table is in the range of 15 to 20 percent. 19,26/ Therefore, recharge to the ground water from precipitation could be as much as 6,170,000 Ml (5,000,000 ac-ft).

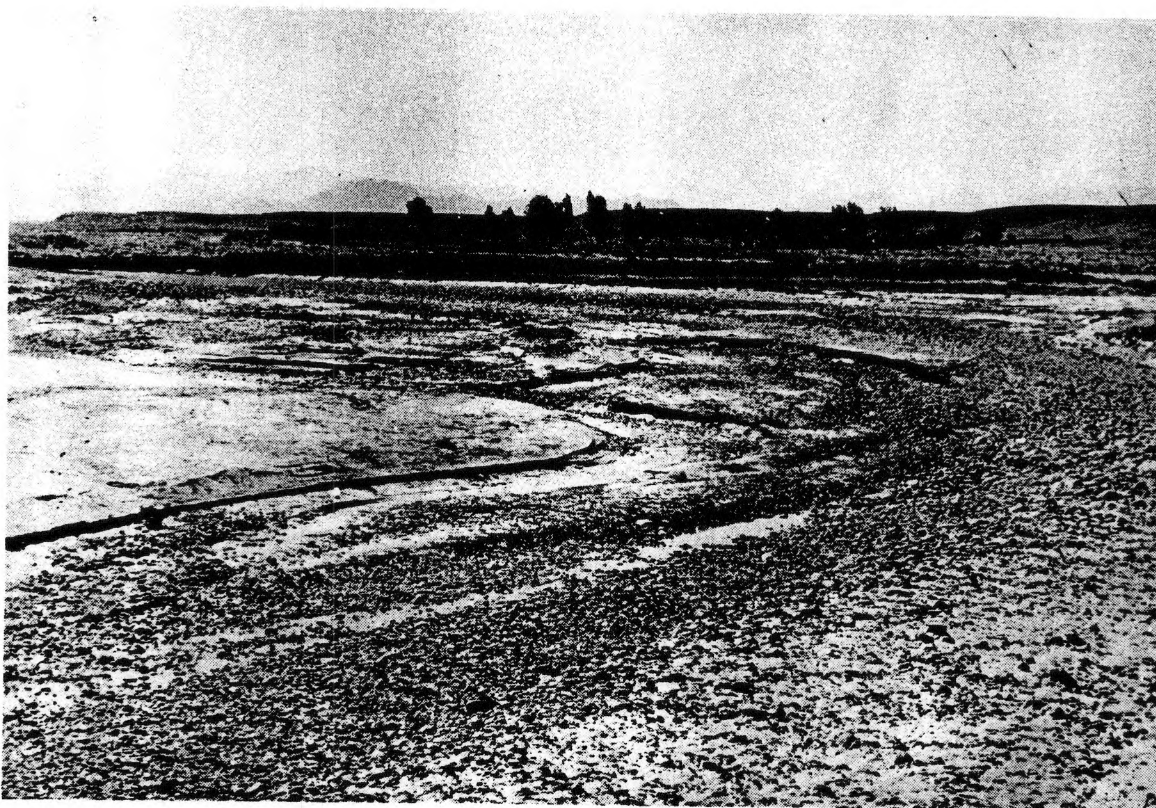


Figure 4-8 A Recharge Area in a Dry Stream Channel

Estimated total diversion from the rivers is 3,948,800 Ml (3,200,000 ac-ft). If 30 percent of this diverted flow were assumed to be annual recharge to the ground water than the recharge could be as much as 1,184,640 Ml (960,000 ac-ft).

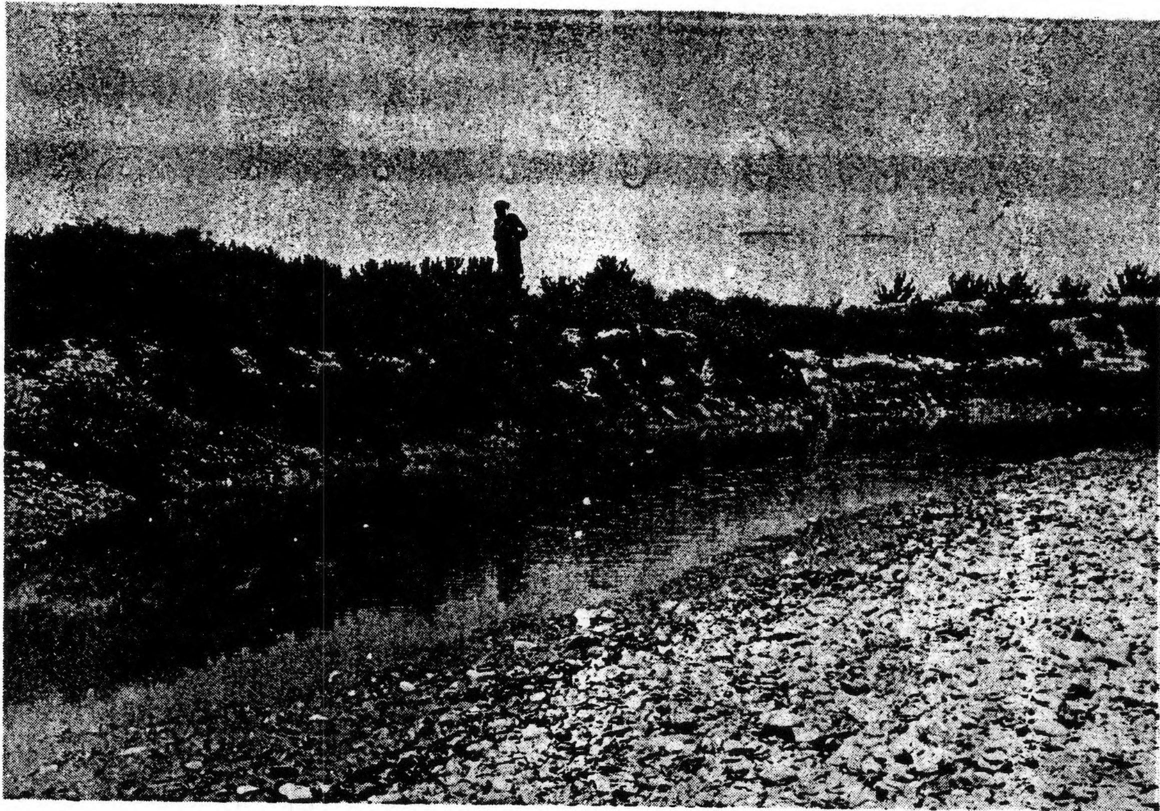


Figure 4-9 A Recharge Area along an Irrigation Canal

The amount of water applied to land as irrigation from wells, karezes and springs is unknown but the figure estimated for all uses from these ground water sources is 345,000 Ml (280,000 ac-ft). If domestic and municipal uses are considered insignificant and if return flow of ground water from wells and karezes is estimated to be 15 percent [26] then the average annual recharge to the ground water reservoir could be as much as 51,750 Ml (42,000 ac-ft).

E. Power, Municipal and Industries - Non-consumptive uses of the surface water resources are also important. The primary non-consumptive use is for power generation. A flow of up to 74 m^3/s

(2,600 cfs) is used to generate electric power by the power plant on the Boghra Canal near Girishk. Also, two small power plants near Kandahar use water from the South Canal. After being used for power generation, the water is available for irrigation use. A hydroelectric power plant is planned in connection with Kajakai Reservoir. This will require constant release flows which should be carefully coordinated with irrigation release demands.

Municipal and industrial use of water is small at present, but is certain to increase in the future. Some water is used in Lashkar Gah to transport waste and sewage. There are 34 km (21 mi) of water and sewer lines in the system in Lashkar Gah.

4.6 SEDIMENTATION

The sedimentation surveys conducted on Kajakai and Arghandab reservoirs and the expected or future sedimentation is covered in this section. Also, discussed are sediment source areas and problems within the basin.

A. Reservoirs

1. Kajakai - A reservoir sedimentation survey which covered the first 15 years of record was completed on Kajakai Reservoir in 1968.[25/] The results showed a loss in capacity of 7.8 percent or 145,242 Ml (117,700 ac-ft).

Redefinition of several contours of the original topographic survey resulted in an increase in capacity of 16,782 Ml (13,600 ac-ft) at spillway elevation. Thus the net change in capacity was 7.0 percent or 120,323 Ml (104,800 ac-ft). After these adjustments had been made the storage capacity was calculated to be 1,716,370 Ml (1,390,900 ac-ft).

If the rate of sedimentation established by the first survey is assumed to have continued until 1976, there would be approximately 221,380 Ml (179,400 ac-ft) of sediment in the reservoir which results in a storage loss of 11.9 percent in 23 years. As of June 1976 there was approximately 1,640,230 Ml (1,329,200 ac-ft) of water storage. The trap efficiency or the ability of the reservoir to retain sediment is estimated to be 92 percent. Table 4-7 shows Kajakai Reservoir sediment data summary.

Based on data developed in the 1968 sedimentation survey, an estimated rate of compaction, and assumption that hydrologic conditions in the watershed do not change appreciably, the principal delta front or forward portion of the sediment deposit will reach the irrigation outlet by year 2020. At that time it is estimated that the reservoir capacity at spillway elevation of 1,033.5 meters (3,390 ft) will be reduced to about 1,480,800 Ml

Table 4-7a

RESERVOIR AND TANK SEDIMENT DATA SUMMARY

KAJAKAI

NAME OF RESERVOIR

DAM

1. CONTROLLING AGENCY HAVA	2. STREAM Helmand	3. PROV. Helmand
	4. NEAREST TOWN	5. DISTRICT
6. LAT 32° 19' " LONG 65° 07' "	7. TOP OF DAM ELEVATION 1,050.0	8. SPILLWAY CREST ELEV. 1,033.5

RESERVOIR

9. STORAGE ALLOCATION	10. ELEVATION TOP OF POOL	11. ORIGINAL SURFACE AREA, Km^2	12. ORIGINAL CAPACITY, MEGALITERS	13. GROSS STORAGE MEGALITERS	14. DATE STORAGE BEGAN
a. FLOOD CONTROL					
b. MULTIPLE USE					Jan. '53
c. POWER					
d. WATER SUPPLY					15. DATE NORMAL OPER. BEGAN
e. IRRIGATION	1,033.5	73.82	1,844,830	1,844,830	
f. CONSERVATION					Jan. '53
g. DEAD					

16. LENGTH OF RESERVOIR 45.1 KM	17. AV. WIDTH OF RESERVOIR 1.64 KM

WATER SHED

18. TOTAL DRAINAGE AREA 49,245 SQ.KM	22. MEAN ANNUAL PRECIPITATION
19. NET SEDIMENT CONTRIBUTING AREA 49,171 SQ.KM	23. MEAN ANNUAL RUNOFF
20. LENGTH 402 KM; AV. WIDTH 121 KM	24. MEAN ANNUAL RUNOFF 6,124,342 MEGALITERS
21. MAX. ELEV. 5,102 METERS; MIN. ELEV. 965 METERS	25. ANNUAL TEMP MEAN RANGE 44° to -33°C

SURVEY DATE

26. DATE OF SURVEY	27. PERIOD YEARS	28. ACCL YEARS	29. TYPE OF SURVEY	30. NO. OF RANGES OR CONTOUR INT.	31. SURFACE AREA Km^2	32. CAPACITY, MEGALITERS	33. C/I RATIO, MI. PER MI.
Jan. 1953	-	-	?	?		1,844,830	0.301
Dec. 1968	16	16	Range (D)	22	73.82	1,716,370 1/	0.280

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW, MEGALITERS a. MEAN ANNUAL	35. b. MAX. ANNUAL	35. c. PERIOD TOTAL	36. WATER INFL. TO DATE MI a. MEAN ANNUAL	36. b. TOTAL TO DATE

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, MEGALITERS a. PERIOD TOTAL	37. b. AV. ANNUAL	37. c. PER SQ. Km. Y-R	38. TOTAL SED DEPOSITS TO DATE, MEGALITERS a. TOTAL TO DATE	38. b. AV. ANNUAL	38. c. PER SQ. Km-Y-R
Jan. 1953	-	-	-	-	-	-
Dec. 1968	145,242	9,078	0.19	145,242	9,078	0.19

26. DATE OF SURVEY	39. AV. DRY WGT, GMS. PER CC	40. SED. DEP. MEGAGRAMS PER SQ. KM-YR a. PERIOD	40. b. TOTAL TO DATE	41. STORAGE LOSS, PCT a. AV. ANN.	41. b. TOT. OF DATE	42. SED. INFLOW, MG/L a. PERIOD	42. b. TOT. TO DATE
Jan. 1953	-	-	-				
Dec. 1968	0.801 *	116,338,840	116,338,340	0.44	7.0 1/		

1/ includes increase of 16,780 Ml capacity found at time of 1968 survey

* estimated

Table 4-7b

RESERVOIR SEDIMENT DATA SUMMARY
SCS-34 Rev. 6-66

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

KAJAKAI
NAME OF RESERVOIR

DATA SHEET NO.

DAM

1. OWNER HAVA	2. STREAM Helmand River	3. STATE Helmand
4. SEC. TWP. RANGE	5. NEAREST P. O.	6. COUNTY
7. LAT. 31° 18′ ″ LONG. 65 ° 07 ′ ″	8. TOP OF DAM ELEVATION 3,445.1	9. SPILLWAY CREST ELEV. 3,390.9

RESERVOIR

10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL	12. ORIGINAL SURFACE AREA, ACRES	13. ORIGINAL CAPACITY, ACRE-FEET	14. GROSS STORAGE, ACRE-FEET	15. DATE STORAGE BEGAN
a. FLOOD CONTROL					
b. MULTIPLE USE					Jan. '53
c. POWER					
d. WATER SUPPLY					16. DATE NORMAL OPER. BEGAN
e. IRRIGATION	3,390.9	18,240	1,495,000	1,495,000	
f. CONSERVATION					Jan. '53
g. INACTIVE					

17. LENGTH OF RESERVOIR 28 MILES	AV. WIDTH OF RESERVOIR 1.02 MILES

WATERSHED

18. TOTAL DRAINAGE AREA 19,013 SQ. MI.		22. MEAN ANNUAL PRECIPITATION INCHES
19. NET SEDIMENT CONTRIBUTING AREA 18,984 SQ. MI.		23. MEAN ANNUAL RUNOFF INCHES
20. LENGTH 250 MILES	AV. WIDTH 76 MILES	24. MEAN ANNUAL RUNOFF 4,963,000 AC.-FT.
21. MAX. ELEV. 16,740	MIN. ELEV. 3,166	25. ANNUAL TEMP.: MEAN RANGE 112° to -27°F

SURVEY DATA

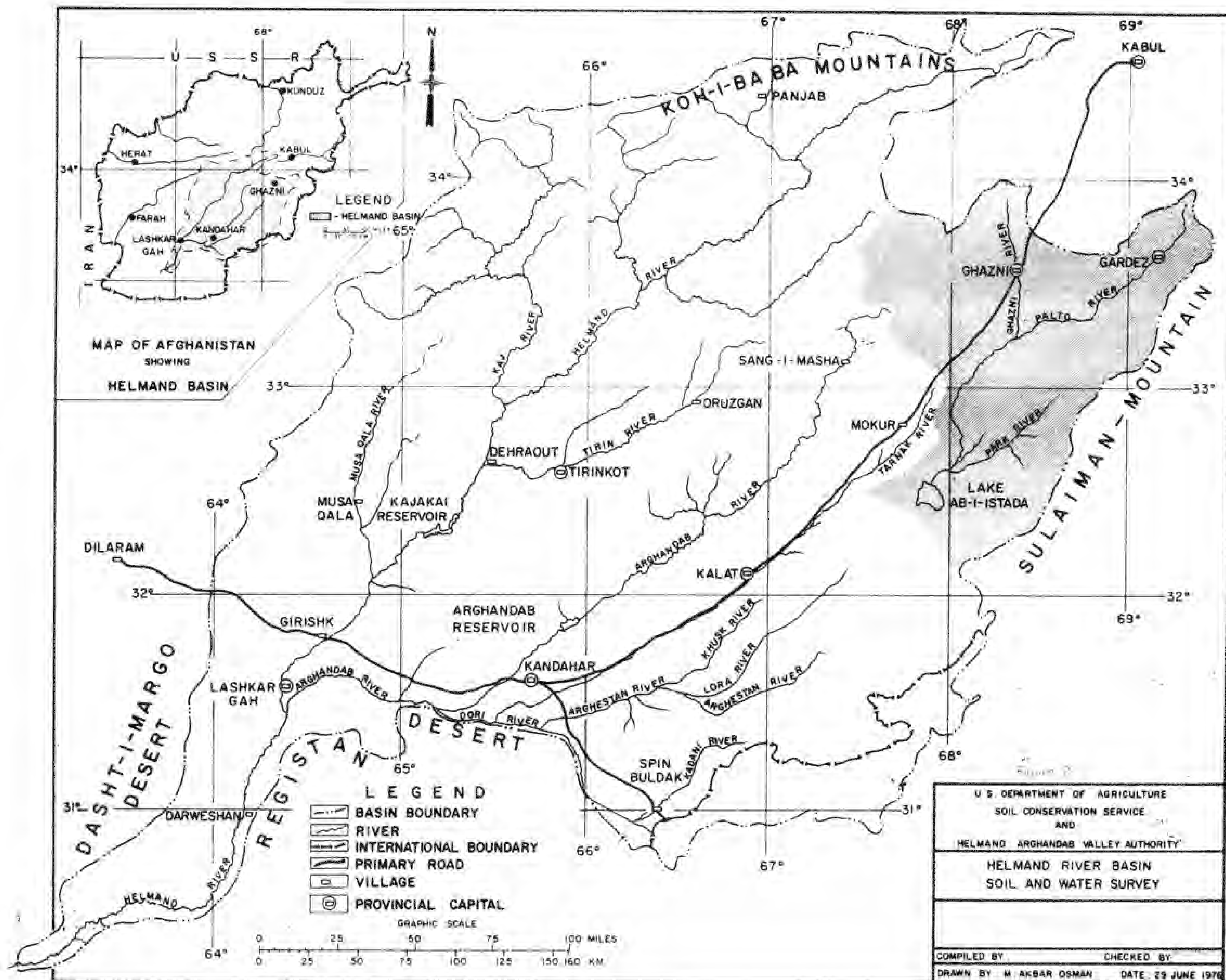
26. DATE OF SURVEY	27. PERIOD YEARS	28. ACCL. YEARS	29. TYPE OF SURVEY	30. NO. OF RANGES OR CONTOUR INT.	31. SURFACE AREA, ACRES	32. CAPACITY, ACRE-FEET	33. C/I. RATIO, AC.-FT. PER AC.-FT.
Jan. 1953	-	-	?	?	-	1,495,000	0.301
Dec. 1968	16	16	Range (D)	22	18,240	1,390,900 1/	0.280

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW, ACRE-FEET			36. WATER INFL. TO DATE, AC.-FT.	
		a. MEAN ANNUAL	b. MAX. ANNUAL	c. PERIOD TOTAL	a. MEAN ANNUAL	b. TOTAL TO DATE

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, ACRE-FEET			38. TOTAL SED. DEPOSITS TO DATE, ACRE-FEET		
	a. PERIOD TOTAL	b. AV. ANNUAL	c. PER SQ. MI.-YEAR	a. TOTAL TO DATE	b. AV. ANNUAL	c. PER SQ. MI.-YEAR
Jan. 1953	-	-	-	-	-	-
Dec. 1968	117,700	6,981	0.36	117,700	6,981	0.36

26. DATE OF SURVEY	39. AV. DRY WGT., LBS. PER CU. FT.	40. SED. DEP., TONS PER SQ. MI.-YR.		41. STORAGE LOSS, PCT.		42. SED. INFLOW, PPM	
		a. PERIOD	b. TOTAL TO DATE	a. AV. ANN.	b. TOT. TO DATE	a. PERIOD	b. TOT. TO DATE
Jan. 1953	-	-	-	-	-	-	-
Dec. 1968	50*	125,609,400	125,609,400	0.44	7.0 1/		

1/ includes increase of 13,600 ac-ft capacity found at time of 1968 survey
* assumed


MAP OF AFGHANISTAN
SHOWING
HELMAND BASIN
U S S R
IRAN
HERAT
KUNDUZ
KABUL
GHAZNI
FARAH
LASHKAR GAH
KANDAHAR
LEGEND
- HELMAND BASIN
N
KOH-I-BABA MOUNTAINS
PANJAB
KABUL
GHAZNI
GARDEZ
GHAZNI RIVER
PALTO RIVER
SULAIMAN - MOUNTAIN
SANG-I-MASHA
ORUZGAN
MOKUR
TARNAK RIVER
PARK RIVER
LAKE AB-I-ISTADA
HELMAND RIVER
KAJ RIVER
MUSA QALA RIVER
DEHRAOUT
TIRIN RIVER
TIRINKOT
MUSA QALA
KAJAKAI RESERVOIR
ARGHANDAB RIVER
KALAT
DILARAM
GIRISHK
ARGHANDAB RESERVOIR
KANDAHAR
KHUSK RIVER
LORA RIVER
ARGHESTAN RIVER
LASHKAR GAH
DORI RIVER
DESERT
REGISTAN
DASHT-I-MARGO DESERT
SPIN BULDAK
KADANI RIVER
DARWESHAN
HELMAND RIVER
64°
65°
66°
67°
68°
69°
31°
32°
33°
34°
LEGEND
BASIN BOUNDARY
RIVER
INTERNATIONAL BOUNDARY
PRIMARY ROAD
VILLAGE
PROVINCIAL CAPITAL
GRAPHIC SCALE
0 25 50 75 100 MILES
0 25 50 75 100 125 150 160 KM
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AND
HELMAND ARGHANDAB VALLEY AUTHORITY
HELMAND RIVER BASIN
SOIL AND WATER SURVEY
COMPILED BY
CHECKED BY
DRAWN BY M. AKBAR OSMAN
DATE 29 JUNE 1976

(1,200,000 ac-ft) or 80 percent of the original capacity as corrected. The trap efficiency with that capacity is estimated to be 90 percent.

2. Arghandab - A reservoir sedimentation survey which covered the first 19 years of record was completed on Arghandab Reservoir in 1971.[24/] The results showed a loss in capacity of 12.6 percent or 39,530 Ml (48,800 ac-ft). If the rate of sedimentation established by the first survey is assumed to have continued until June 1976 there would be approximately 49,610 Ml (61,250 ac-ft) of sediment in the reservoir which results in a storage loss of 15.8 percent in 24 years. As of June 1976, there was approximately 403,300 Ml (326,800 ac-ft) of water storage. The trap efficiency or the ability of the reservoir to retain sediment is estimated to be 95 percent. Table 4-8 shows Arghandab Reservoir sediment data summary.

Assuming the rate of sedimentation established by the 1971 survey continues then theoretically the reservoir will fill with sediment by the year 2110. However, a number of factors will affect the rate of sedimentation. As more sediment is deposited in the reservoir the water storage is reduced and the trap efficiency is lowered. As the trap efficiency is lowered more sediment will go through the spillway, and the rate the reservoir fills with sediment is reduced. The amount of water diverted upstream from the reservoir and the amount

Table 4-8a

RESERVOIR AND TANK SEDIMENT DATA SUMMARY

ARGHANDAB

NAME OF RESERVOIR

DAM	1. CONTROLLING AGENCY HAVA	2. STREAM Arghandab	3. PROV. Kandahar
		4. NEAREST TOWN	5. DISTRICT
	6. LAT 31° 51' " LONG 65° 52' 30"	7. TOP OF DAM ELEVATION 1,115.0	8. SPILLWAY CREST ELEV 1,110.0

RESERVOIR: 9. STORAGE ALLOCATION	10. ELEVATION TOP OF POOL	11. ORIGINAL SURFACE AREA, Km²	12. ORIGINAL CAPACITY, MEGALITERS	13. GROSS STORAGE MEGALITERS	14. DATE STORAGE BEGAN
a. FLOOD CONTROL					
b. MULTIPLE USE					Feb 24, '52
c. POWER					
d. WATER SUPPLY					15. DATE NORMAL OPER BEGAN
e. IRRIGATION	1,110.0	30.0	478,792	478,792	
f. CONSERVATION					Feb 24, '52
g. DEAD					

16. LENGTH OF RESERVOIR 18.9 KM	17. AV WIDTH OF RESERVOIR 1,609 KM
WATER SHED: 18. TOTAL DRAINAGE AREA 13,509 SQ KM	22. MEAN ANNUAL PRECIPITATION
19. NET SEDIMENT CONTRIBUTING AREA 11,806 SQ KM	23. MEAN ANNUAL RUNOFF
20. LENGTH 209 KM; AV. WIDTH 60 KM	24. MEAN ANNUAL RUNOFF 1,242,144 MEGALITERS
21. MAX. ELEV 4,232 METERS; MIN. ELEV 1,065 METERS	25. ANNUAL TEMP MEAN RANGE 44°C to -21°C

26. DATE OF SURVEY	27. PERIOD YEARS	28. ACCL. YEARS	29. TYPE OF SURVEY	30. NO. OF RANGES OR CONTOUR INT	31. SURFACE AREA Km²	32. CAPACITY, MEGALITERS	33. C/I RATIO, MI PER MI.
Feb. 1952	-	-	?	?	?	478,792	0.385
Sept. 1971	19.66	19.66	Range (D)	19 R	30.0	418,573	0.337

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW, MEGALITERS: a. MEAN ANNUAL	b. MAX ANNUAL	c. PERIOD TOTAL	36. WATER INFL TO DATE MI: a. MEAN ANNUAL	b. TOTAL TO DATE

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, MEGALITERS: a. PERIOD TOTAL	b. AV. ANNUAL	c. PER SQ Km Y-R	38. TOTAL SED DEPOSITS TO DATE, MEGALITERS: a. TOTAL TO DATE	b. AV. ANNUAL	c. PER SQ Km-Y-R
Feb. 1952	-	-	-	-	-	-
Sept. 1971	60,219	3,063	0.26	60,219	3,063	0.26

26. DATE OF SURVEY	39. AV DRY WGT. GMS. PER CC	40. SED. DEP MEGAGRAMS PER SQ KM-YR: a. PERIOD	b. TOTAL TO DATE	41. STORAGE LOSS, PCT: a. AV. ANN	b. TOT OF DATE	42. SED. INFLOW, MG/L: a. PERIOD	b. TOT TO DATE
Feb. 1952	-	-	-	-	-	-	-
Sept. 1971	0.801*	48,235,419	48,235,419	0.64	12.6		

* estimated

Table 4-8b

RESERVOIR SEDIMENT DATA SUMMARY
SCS 34 Rev. 6-66

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

ARGHANDAB
NAME OF RESERVOIR

DATA SHEET NO.

DAM

1. OWNER HAVA	2. STREAM Arghandab	3. STATE Kandahar
4. SEC. TWP. RANGE	5. NEAREST P.O.	6. COUNTY
7. LAT. 31° 51 ' " LONG. 65° 52 ' 30 "	8. TOP OF DAM ELEVATION 3,658.3	9. SPILLWAY CREST ELEV. 3,641.9

RESERVOIR

10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL	12. ORIGINAL SURFACE AREA, ACRES	13. ORIGINAL CAPACITY, ACRE-FEET	14. GROSS STORAGE, ACRE-FEET	15. DATE STORAGE BEGAN
a. FLOOD CONTROL					
b. MULTIPLE USE					Feb. 24, '52
c. POWER					
d. WATER SUPPLY					16. DATE NORMAL OPER. BEGAN
e. IRRIGATION	3,641.9	7,421	388,000	388,000	
f. CONSERVATION					Feb. '52
g. INACTIVE					

17. LENGTH OF RESERVOIR 11.7 MILES	AV. WIDTH OF RESERVOIR 1.0 MILES

WATERSHED

18. TOTAL DRAINAGE AREA 5,216 SQ. MI.		22. MEAN ANNUAL PRECIPITATION INCHES
19. NET SEDIMENT CONTRIBUTING AREA 4,558 SQ. MI.		23. MEAN ANNUAL RUNOFF INCHES
20. LENGTH 130 MILES	AV. WIDTH 37.5 MILES	24. MEAN ANNUAL RUNOFF 1,006,600 AC.-F.T.
21. MAX. ELEV. 13,884	MIN. ELEV. 3,494	25. ANNUAL TEMP: MEAN RANGE 112° to -6° F

SURVEY DATA

26. DATE OF SURVEY	27. PERIOD YEARS	28. ACCL. YEARS	29. TYPE OF SURVEY	30. NO. OF RANGES OR CONTOUR INT.	31. SURFACE AREA, ACRES	32. CAPACITY, ACRE-FEET	33. C/I. RATIO, AC.-FT. PER AC.-FT.
Feb. '52	-	-	-	-		388,000	0.385
Sept. '71	19.7	19.7	Range (D)	19 R	7,421	339,200	0.337

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIPITATION	35. PERIOD WATER INFLOW, ACRE-FEET			36. WATER INFL. TO DATE, AC.-FT.	
		a. MEAN ANNUAL	b. MAX. ANNUAL	c. PERIOD TOTAL	a. MEAN ANNUAL	b. TOTAL TO DATE

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, ACRE-FEET			38. TOTAL SED. DEPOSITS TO DATE, ACRE-FEET		
	a. PERIOD TOTAL	b. AV. ANNUAL	c. PER SQ. MI.-YEAR	a. TOTAL TO DATE	b. AV. ANNUAL	c. PER SQ. MI.-YEAR
Feb. '52	-	-	-	-	-	-
Sept. '71	48,800	2,482	0.55	48,800	2,482	0.55

26. DATE OF SURVEY	39. AV. DRY WGT., LBS. PER CU. FT.	40. SED. DEP., TONS PER SQ. MI.-YR.		41. STORAGE LOSS, PCT.		42. SED. INFLOW, PPM	
		a. PERIOD	b. TOTAL TO DATE	a. AV. ANN.	b. TOT. TO DATE	a. PERIOD	b. TOT. TO DATE
Feb. '52	-	-	-	-	-		
Sept. '71	50*	53,143,200	53,143,200	0.64	12.6		

* assumed

released for irrigation will also affect the rate of sedimentation.

From the above discussion it can be seen that the straight line method of predicting the life of a reservoir is conservative. The actual time it takes before the reservoir is filled with sediment will be later than the above stated year 2110. However, it can be stated with some confidence that the reservoir can be expected to be about half filled with sediment by 2040 if conditions on the watershed remain constant.

B. Sediment Source Areas and Problems - The few local high intensity storms which occur in the basin probably cause high sediment concentrations in the streams. This is because raindrop impact dislodges soil and the high peak discharge carries it to the stream. Raindrop impact causes sheet erosion and the resultant runoff contributes mostly to rill and gully erosion. When runoff is contributed by snowmelt, there is no raindrop impact so the erosion is only of the rill and gully type.

Rain is the dominant type of precipitation on the Desert Plain Resource Area. Slopes are very gentle and runoff infrequent with low velocity. Low velocity, infrequent runoff does not encourage gully formation so the major source of sediment is expected to be from sheet erosion.

The Mountains and Desert Upland Resource Areas contribute most of the runoff and the precipitation comes in the form of snow and to a

lesser extent rain. These areas contribute the highest sediment yields. The major source in these areas appears to be from streambanks and gullies. There are likely to be however, some areas where sheet erosion is the major contributor to the sediment yield.



Figure 4-10 Streambank Erosion

Construction of Kajakai and Arghandab Dams has greatly reduced the volume of suspended material downstream in the rivers. The sediment removed when water is stored increases the potential capacity for scour of the river banks and bed below the dams. Visual observation of the river channels some 20 km (12 mi) below the dams indicates that from that point downstream, gravel armour is adequate to protect the bed from the increased energy available to the clearer water. Be ' erosion or degradation immediately below

Kajakai Dam is occuring and is expected to continue until the channel reaches equilibrium with the infrequent maximum discharges. The river banks are another source of erosion and if they are not protected, some erosion will continue to occur.

The volume of sediment presently required to be removed from the canals is only a small portion of that required before construction of Kajakai and Arghandab Dams. However, removal of sediment is still a major maintenance problem and is magnified where wind blown material drifts into the canals.[6/]

Most farmer built and maintained canals diverting water from the major rivers have a problem with sediment carried by rainfall runoff from the surrounding desert areas.[6/] Storm flows wash across or drain into canals after they have filled with water or sediment. The Seraj Canal is probably affected by this condition more than any other.

Almost all of the old canals built and maintained by farmers are operating without drain inlets, siphons, storm flow overshoots, wasteways, or control gates. The losses due to interruptions of water service are probably substantial. The cost of removing sediment is considerable.

All of these sediment source areas share a common problem. They all lack sufficient vegetation to protect the soil from erosion. The Desert Plains Resource Area has insufficient rainfall to support adequate

cover and in the Desert Uplands and Mountains Resource Areas the vegetation is almost completely removed by the unrestricted grazing of animals.

4.7 POTENTIAL DEVELOPMENT

Many possibilities exist to develop additional water in the Helmand River Basin.

Water can be managed more efficiently thereby requiring less to be diverted and releasing more for use on other lands. Additional storage can be provided to retain high flows which occur in the spring for release in the summer. Storage can also be provided to carry water from years of high flow over to years of low flow. Water can be pumped from underground sources. The weather can be modified by cloud seeding to increase precipitation. The amount of evaporation from water surfaces can be reduced. The amount of water that watersheds yield in the form of runoff can be changed by land treatment of the watershed. Channels which transport water can be improved to reduce the losses in transit. Sediment deposition in reservoirs can be reduced thus retaining existing storage capacity for a longer period of time. Also, flood control can be provided which will reduce the peak flows and detain floodwater thus allowing greater infiltration into the ground and less runoff from the watershed. All these methods of potential development are discussed in this section.

A. Improved Water Management - One of the foremost potentials for overcoming water shortages, providing additional water for development, and reducing drainage problems lies in improving the efficiency of water use. This should be considered in two parts - delivery systems and on-farm water management. Delivery systems can be upgraded by canal lining through high loss areas, using more efficient diversion structures and constructing more effective measurement and management controls. The consolidation of parallel canal systems is another of the significant development potentials. Irrigation practices on individual farms probably have the greatest potential to improve water use and management. The potential is especially great for better management and regulation of water applied on individual fields.

For example, ditch lining and land leveling can increase on-farm irrigation efficiency as much as 25 to 30 percent when properly designed. The use of furrow irrigation can increase efficiencies to 50 to 70 percent while use of basins and borders can raise efficiencies to 60 to 80 percent.

There are limits on the efficiencies which can be attained, since some losses such as evaporation and seepage are difficult and costly to control. Some areas will require extra water for leaching

of salts from the soil. An overall irrigation efficiency greater than 60 percent will be difficult to obtain. An on-farm efficiency of 70 percent and a delivery efficiency of 85 percent will be about the upper limit that can be obtained without extensive facilities for delivery and distribution, and considerable training and experience in water management.

However, when these obtainable efficiencies are compared to the existing efficiencies of 35 percent overall, 48 percent on-farm, and 73 percent delivery, it can be seen there is much room for improvement.

There is an estimated 3,948,800 Ml (3,200,000 ac-ft) of water diverted annually to irrigated cropland from rivers and streams in the Helmand River Basin. If the overall use efficiency from diversion to root zone was increased 10 percent, approximately 863,800 Ml (700,000 ac-ft) of additional water would be made available for use on other land.

As irrigation efficiencies improve, less water will be delivered to the laterals and less water will be applied to the fields. This will decrease the amount of water that drains from the irrigated areas and increase the concentration of salt in the drainage water. When these waters return to the stream, they will decrease the quality to the next user downstream.

B Reservoir Storage - The Kajakai and Arghandab Reservoir facilities are important parts of the water resource scheme. The storage capacity of Kajakai as of June 1976 is estimated at 1,640,230 Ml (1,329,200 ac-ft). This is less than 27 percent of the average annual discharge of the Helmand River at this point on the river. The storage capacity of the Arghandab Reservoir as of June 1976 is estimated at 403,300 Ml (326,800 ac-ft) which is approximately 32 percent of the average annual inflow of the Arghandab Reservoir.

The amount of additional water that is available for storage varies considerably from year to year. The total amount of storage which should be provided will have to be determined in the future. Careful consideration must be given in order to provide adequate but not excessive storage amounts. For example, based on the 1948 through 1975 streamflow records, if storage was provided on the Helmand River above Kajakai for approximately 6,170,000 Ml (5,000,000 ac-ft) the reservoirs would only fill 16 out of 28 years. Whereas, if storage was provided for 4,936,000 Ml (4,000,000 ac-ft) the reservoirs would fill 20 out of 28 years. On the Arghandab River above the Arghandab Reservoir, if total storage for the annual average flow of 1,234,000 Ml (1,000,000 ac-ft) was provided, the reservoirs would fill only 13 out of 28 years, and in three out of 28 years the reservoirs would be less than half filled.

Maydan, Paktya, Oruzgon, Ghazni and Zabul provinces. The province boundaries are shown in Figure 2-2.

The mountain ranges trend in a northeasterly-southwesterly direction and valleys are long and narrow. Elevations range from 5,100 m (16,740 ft) to 570 m (1,870 ft).

The Helmand River is the major stream in the basin. The Arghandab, Kaj, Tirin and Musa Qala Rivers are the major tributaries. The Tarnak, Arghestan and Dori Rivers are the major tributaries to the Arghandab River.

Streams which have a major portion of their watersheds in the Mountains Resource Area, such as the Tirin and Kaj Rivers, are perennial. Those which have the major portion of their watershed in the Desert Upland Resource Area, such as the Musa Qala River are intermittent. Any stream whose watershed is predominantly within the Desert Plains Resource Area are both intermittent and ephemeral in that they flow only in response to precipitation.

2.2 RESOURCE AREAS

Resource areas have similar climate, geology, hydrology, and soils and are adapted to like crops. These areas are useful for broad planning purposes because they associate areas of like characteristics across watershed boundaries. They are used as reference points for discussion and are

Little is known concerning potential reservoir sites for water storage. Apparently there are some sites on the Helmand and Arghandab Rivers and their tributaries where new reservoirs could be built to provide water storage capacity for full development of the water resources. Although some investigations were thought to have been made, no reports concerning potential reservoir sites were found. A review of topographic and geologic maps was made and some information was obtained from the personal knowledge of Afghan Counterparts. Based on this information, limited field review, and experience in other areas of similar characteristics, it would be safe to assume that reservoir sites do exist within the basin.

Since there is undeveloped water resources in the rivers, additional reservoir storage will probably be developed sometime in the future. Considerable information will be needed to adequately determine the location of potential sites. Geologic studies, hydrologic investigations, topographic surveys, and soils testing will be required on each possible site. Reservoirs developed primarily for irrigation purposes should also provide for floodwater detention and sediment storage.

One storage development that has already been studied is the proposed spillway gates at Kajakai reservoir. With this installation, the capacity will be increased to 2,650,000 Ml (2,147,500 ac-ft). This would provide storage for approximately 43 percent of the average annual inflow

to Kajakai reservoir, and it would fill 27 out of 28 years.

C. <u>Ground Water Development</u> - Very little is known about the ground water potential. This is because only a few wells have penetrated aquifers below 30 m (100 ft) and all of these were less than 200 m (500 ft) deep. Most information on depths, logs and even locations of several reported wells, is apparently no longer available, and much useful data have thus been lost or mislaid. Data available on the few deep wells which have been drilled in the basin indicate that at least locally, wells of low to moderate yield can be constructed and that possibilities exist for wells of large yield.[17/] In one portion of the Kandahar area water is confined under sufficient pressure to flow at the surface. The possibility for artesian conditions exist in other portions of the watershed.

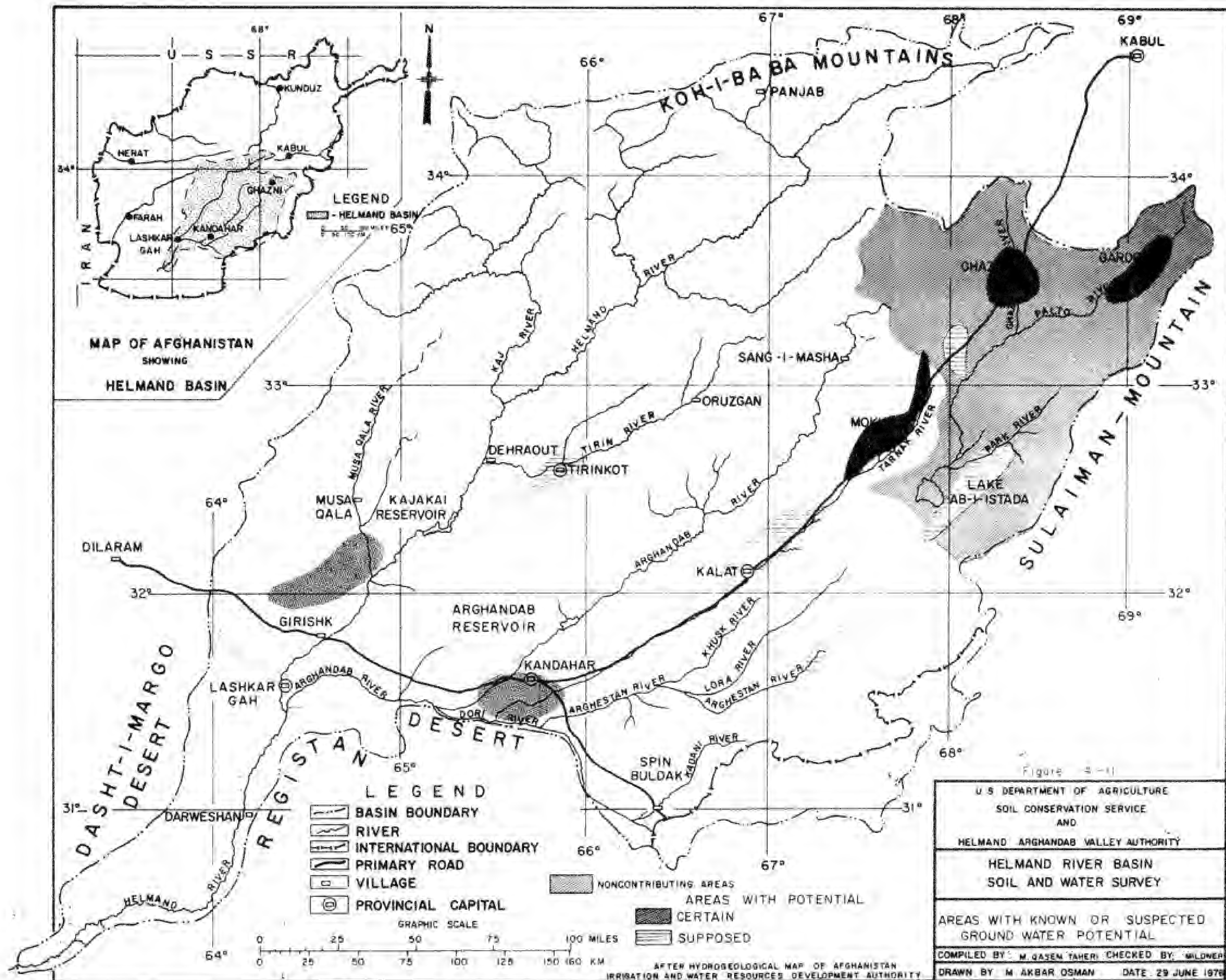
Just the description of ground water occurrence at this time is not sufficient where large pumpage or importation of water is projected to take place. A time dimension or span of time must be considered. Recharge and discharge must be estimated and the effects of long term changes predicted. Water levels may rise and fall and water quality may change with time. To make such predictions and to guide later studies and development, deep exploratory drilling is needed.

The effects of withdrawals of water or of application of water may

be estimated crudely but cannot be predicted quantitatively, unless studies are made of the ground water and its environment. Likewise predictions cannot be evaluated or modified in the absence of data from a complete program of monitoring. Figure 4-11 shows the areas with known or suspected potential for ground water development. The potential yield and quality from the areas shown are not known.

D. Weather Modification - Weather modification (cloud seeding) techniques are being developed in some parts of the world and may prove to be feasible for controlled use in Afghanistan sometime in the future. Although cloud seeding might possibly increase the water supply to the Helmand River Basin, the possibility of doing so in the near future is extremely remote. Considerable meterological data are needed to accurately interpret storm clouds and predict their potential for successful seeding. Also, the physical facilities needed, require extensive training and experience to operate. Immediate, unrestricted access to weather data, rapid and complete communications, and rapid clearance for air traffic are additional requirements for a successful cloud seeding program.

The meteorological data needed for an accurate and complete water budget analysis, as previously stated, are even more important if a full scale weather modification program is to be undertaken in Afghanistan.



MAP OF AFGHANISTAN
SHOWING
HELMAND BASIN
U — S — S — R
IRAN
KUNDUZ
HERAT
KABUL
GHAZNI
FARAH
LASHKAR GAH
KANDAHAR
LEGEND
- HELMAND BASIN
KOH-I-BABA MOUNTAINS
PANJAB
KABUL
SANG-I-MASHA
ORUZGAN
DEHRAOUT
TIRINKOT
TIRIN RIVER
HELMAND RIVER
KAJ RIVER
MUSA QALA RIVER
MUSA QALA
KAJAKAI RESERVOIR
DILARAM
GIRISHK
ARGHANDAB RESERVOIR
ARGHANDAB RIVER
KALAT
KANDAHAR
LASHKAR GAH
ARGHESTAN RIVER
LORA RIVER
KHUSK RIVER
DORI RIVER
KADANI RIVER
SPIN BULDAK
TARNAK RIVER
PALTO RIVER
PARK RIVER
LAKE AB-I-ISTADA
SULAIMAN MOUNTAIN
DASHT-I-MARGO DESERT
REGISTAN DESERT
DARWESHAN
HELMAND RIVER
LEGEND
BASIN BOUNDARY
RIVER
INTERNATIONAL BOUNDARY
PRIMARY ROAD
VILLAGE
PROVINCIAL CAPITAL
GRAPHIC SCALE
0 25 50 75 100 MILES
0 25 50 75 100 125 150 160 KM
NONCONTRIBUTING AREAS
AREAS WITH POTENTIAL
CERTAIN
SUPPOSED
AFTER HYDROGEOLOGICAL MAP OF AFGHANISTAN
IRRIGATION AND WATER RESOURCES DEVELOPMENT AUTHORITY
Figure 4-11
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AND
HELMAND ARGHANDAB VALLEY AUTHORITY
HELMAND RIVER BASIN
SOIL AND WATER SURVEY
AREAS WITH KNOWN OR SUSPECTED
GROUND WATER POTENTIAL
COMPILED BY: M. QASEM TAHERI CHECKED BY: MILDNER
DRAWN BY M. AKBAR OSMAN DATE 29 JUNE 1976

E. Evaporation Reduction - Another possible method of water resource development is to reduce the evaporation from water surfaces through the use of chemical suppressant. These have been successful in some instances but have many limitations. Costs for the material, cost of application, availability of material, and technical ability to operate and maintain such a program are first considerations. Also, the success in this area where winds flow regularly from the same direction would be doubtful. And finally, Kajakai and Arghandab Reservoirs are the only bodies of water that would be practical to treat, and if evaporation were stopped completely, only 183,800 Ml (149,000 ac-ft) of water would be saved annually.

F. Water Yield Improvement - Some research conducted in other countries has shown that water yields to streams and rivers or ground water can be increased by watershed land treatment. This research has been conducted on limited areas and the results are not conclusive that a net yield can be achieved over an extended period. Feasibility is generally limited by costs, inadequate knowledge of specific methods applicable to a given area, and a lack of information about what effects extensive watershed treatment would have on other resources and their uses. Considerable care should be taken in applying specific research findings to other areas where conditions may differ.

It does not appear that watershed land treatment as a method of developing additional water resources is presently practicable in the Helmand River Basin. However, other benefits such as increased forage, reduced on-site erosion, reduced sedimentation in streams and reservoirs, and reduction of flood peaks may arise from watershed treatment. Changes in watershed conditions would probably change the precipitation yield relationship; how much and in which direction is not known.

G. Channel Improvement - Stream channels and wasteways may be improved by removing vegetation and reshaping to provide better drainage of high water table areas. Some tributary channels, particularly in the irrigated areas, could be improved to reduce transmission losses caused by evaporation, transpiration and seepage, and to route flash floods and non-beneficial runoff through cultivated areas.

The total length of channels and wasteways is unknown. It is estimated that the amount of water developed through channel improvement would be small. However, it may be important since the water would generally be in irrigated areas where, if the quality were adequate, it could be reused readily.

Even though water savings may be small, other benefits gained by pro-

viding better drainage and flood control would probably justify further investigation to determine the amount of channel improvement that could be provided.

H. Sediment Control - Land treatment and structural measures are the usual methods of reducing erosion and the resultant sediment yield. Any reduction in sediment yield above the reservoirs will, of course, prolong the life of Kajakai, Arghandab, and any future reservoirs.

Land treatment on non-cultivated land is usually restricted to establishment or the re-establishment of vegetation. There is insufficient rainfall to permit re-establishment of a natural vegetative cover sufficient to be effective against either wind or water erosion in the Desert Plain Resource Area. Those areas in the Desert Upland and Mountains Resource Areas with adequate soil are suitable for land treatment. In fact, there may be sufficient stand of natural vegetation already there to provide erosion protection if it were permitted to grow. The effect that the natural vegetation may have in controlling erosion is greatly reduced by the close grazing of sheep and goats.

Land treatment is usually only effective as a preventative measure for sheet and rill erosion. Streambank and gully erosion is usually controlled by structural measures. Structural measures consist of gully plugs, drop structures, and various stream bank protection

methods. All of these structural methods are expensive and their costs may not be justified by their benefits.

Since the major source of erosion in the basin is from streambanks and gullies, structural measures will be the most effective practice to apply. Land treatment will be effective on certain areas and on a smaller percentage of the total but it could provide a substantial reduction in sediment yield, for a fraction of the cost of structural measures.

There is another structural measure which differs from those mentioned above in that it does not attempt to control erosion but only to prolong the life of major reservoirs. That method is to construct debris or sediment basins above the reservoirs.

These structures could serve additional purposes of storage and regulating reservoirs and provide flood control benefits until filled with sediment. They will do little toward reducing streambank and gully erosion as their effect for this purpose would only be in their immediate reservoir area. They would eventually become ineffective as sediment traps when filled with sediment but would serve to increase the longevity of the major reservoirs.

A sedimentation survey of the basin to determine the amount, type, location, and cost of necessary treatment would be desirable. Also

the expected effect of the treatment would be determined so that a cost benefit analysis could be made.

I. Flood Reduction - Flood damages can be reduced by providing structural measures to detain, divert, or store peak flood flows. This will reduce the damage caused to roads, homes, canals, diversions, and farmland as well as allowing the water more time to infiltrate into the ground.

Structural measures which generally provide the best flood control are small dams which temporarily store or detain the flow and reduce the peak discharge and by dikes and channels which divert the flow away from areas of high damage potential.

From a very limited observation, there appears to be several areas where flood control structures would be beneficial and could be installed.

However, a flood damage study along with a study of flood potential will be needed to determine extent of damages and costs of control structures.

4.8 CONCLUSIONS AND RECOMMENDATIONS

This section includes conclusions and recommendations along with a brief discussion. These are given under the headings of water supply,

water use, irrigation, sedimentation, and ground water. No attempt was made to list the recommendations by priority.

A. Water Supply - The total water resource of the Helmand River Basin is not adequately known to allow detailed water budget analysis. Streamflow data and meteorological data are not of sufficient duration or detail to provide the information that will be needed to carefully and accurately predict, develop, and regulate the water resources. Need for adequate data will become critical as development expands and the demand for water and use of water approaches the available supply.

It is important for the development and management of Afghanistan's water resource, that all information and data on water be available to those who need it. Meteorological and snowpack data along with streamflow data must be recorded, tabulated and distributed in a timely manner and over a long period of time to be of value in total water resource planning. Future investigations and analysis of water resources of this or any area can not be made accurately and completely without the hydrologic data provided by these measurements.

A review of progress made since 1968 should be made to more accurately determine needs. All records taken since 1968 should be reviewed and brought up to date and up to acceptable standards. All streamflow,

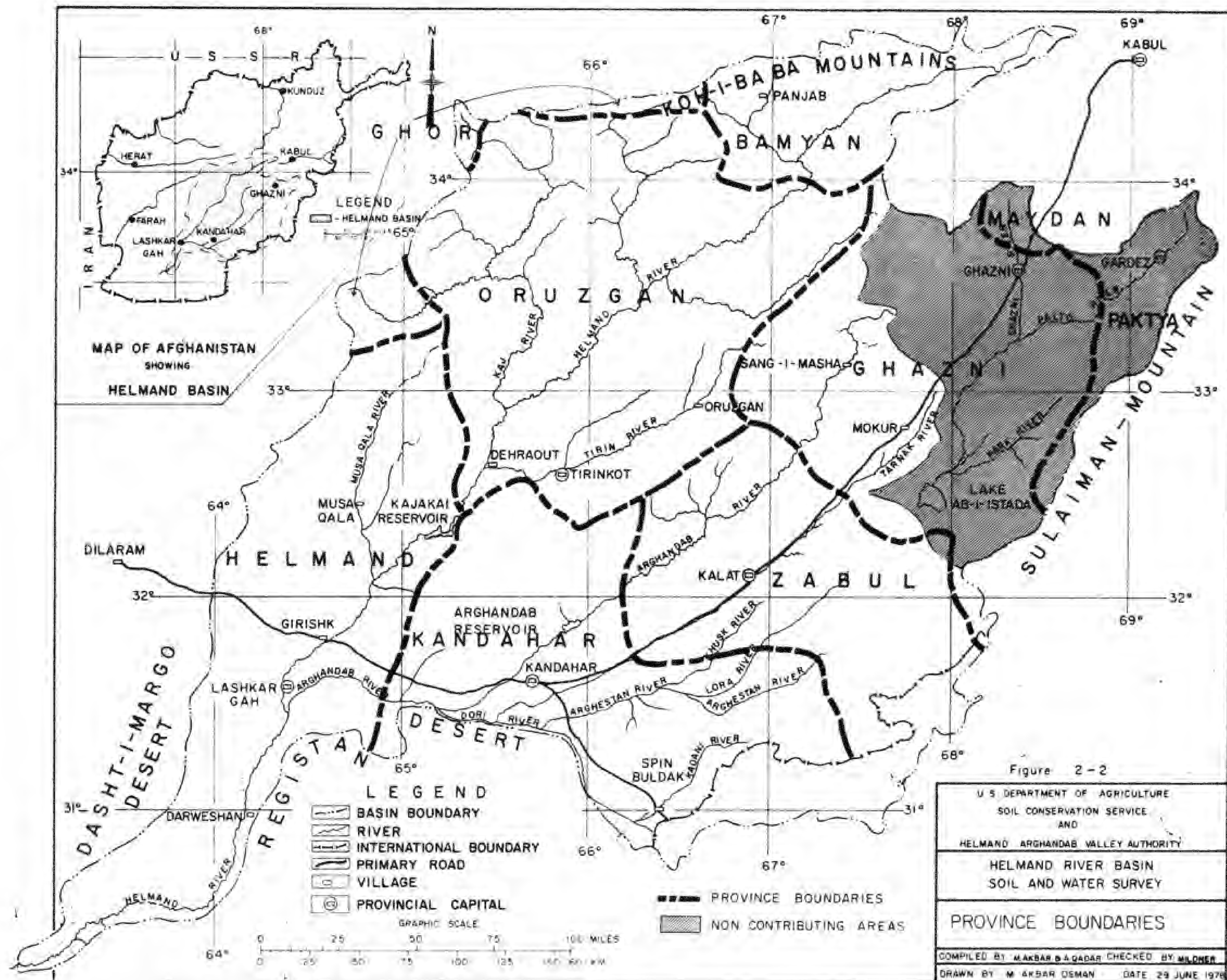

MAP OF AFGHANISTAN
SHOWING
HELMAND BASIN
U S S R
IRAN
KUNDUZ
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KABUL
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FARAH
KANDAHAR
LASHKAR GAH
LEGEND
HELMAND BASIN
KOH-I-BABA MOUNTAINS
PANJAB
GHOR
BAMYAN
ORUZGAN
MAYDAN
GHAZNI
GARDEZ
PAKTYA
SANG-I-MASHA
G H A Z N I
ORUZGAN
MOKUR
LAKE AB-I-ISTADA
SULAIMAN-MOUNTAIN
DEHRAOUT
TIRINKOT
MUSA QALA
KAJAKAI RESERVOIR
DILARAM
H E L M A N D
KALAT
Z A B U L
GIRISHK
ARGHANDAB RESERVOIR
K A N D A H A R
KANDAHAR
LASHKAR GAH
DASHT-I-MARGO DESERT
REGISTAN DESERT
SPIN BULDAK
DARWESHAN
KAJ RIVER
HELMAND RIVER
MUSA QALA RIVER
TIRIN RIVER
ARGHANDAB RIVER
TARNAK RIVER
KUSHK RIVER
LORA RIVER
ARGHESTAN RIVER
DORI RIVER
KADANI RIVER
L E G E N D
BASIN BOUNDARY
RIVER
INTERNATIONAL BOUNDARY
PRIMARY ROAD
VILLAGE
PROVINCIAL CAPITAL
GRAPHIC SCALE
0 25 50 75 100 MILES
0 25 50 75 100 125 150 160 KM
PROVINCE BOUNDARIES
NON CONTRIBUTING AREAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AND
HELMAND ARGHANDAB VALLEY AUTHORITY
HELMAND RIVER BASIN
SOIL AND WATER SURVEY
PROVINCE BOUNDARIES
COMPILED BY M AKBAR B A QADAR CHECKED BY MILDNER
DRAWN BY M AKBAR OSMAN DATE 29 JUNE 1976

Figure 2 - 2

reservoir, and climatological records since the last published report should be compiled and published. The training needs of Afghan technicians and engineers in various phases of hydrology should be re-evaluated.

The Helmand River Basin has perhaps the best stream gaging network and streamflow data in all of Afghanistan at some points. It is most important that the meteorological and stream gaging network already established should be maintained and operated regularly even though problems are encountered. Existing meteorological and stream gaging stations may need to be rebuilt or repaired. New equipment may be needed at some stations. Some new stations may need to be established. New well-equipped vehicles may be needed to provide adequate transportation.

B. Water Use - Information on water uses in the Helmand River Basin is inadequate for proper analysis of the supply-use relationship. Data on diversion and distribution of water to irrigated cropland are not of sufficient detail in areas outside of project areas. Data on consumptive use, cropping patterns, and on-farm irrigation efficiency are not adequate for detailed water analysis of the entire Helmand River Basin.

Measurements should continue to be made of water diverted from

streams and delivered to farm laterals. Measurements should be made at all diversions especially those in the non-project areas. Studies should be made to determine consumptive use for various crops and cropping patterns. Consumptive use by other vegetation should also be determined.

The proper use and management of the water resource is critical to the future of the Helmand River Basin as a major agricultural area. Those who must make decisions should carefully ascertain the long term effects and priorities of water resource uses to prevent unforeseen and undesirable impacts. As demands increase on the water supply, it will become more necessary to give proper consideration to both consumptive and non-consumptive uses.

C. Irrigation - There is both too much and too little water, often within the same irrigated areas. All irrigation water is not distributed equally among users within one area or even within one lateral. Also, seepage and management losses associated with distribution and irrigation water transportation often alter distribution. Water use by phreatophytes or water-loving plants, growing along canals increase water losses as well as restricting the flow and reducing canal carrying capacities. Irrigation efficiencies on the farm and in the canal systems can be improved. Considerable

water can be released or made available for use on other lands or for other purposes by properly managing the available supply.

Opportunities for reducing quantities of dissolved solids in the drainage water at present are fairly good in most areas. Enough water is presently available to allow excess water to be delivered for leaching of the soil. As much as 15 percent extra water should be allowed for leaching in some areas. Careful control will have to be exercised to avoid causing a water-logging problem.

Extensive irrigation developments will further contribute to return flows which will be used and reused as the water makes its way downstream. With each diversion, additional amounts of dissolved solids will be leached from the soil and returned to the river. This salt problem will become aggravated as more and more water is used for irrigation.

Improvements can be made in the diversion and distribution of water to the farms or farm laterals. In those areas where the farmer built or traditional diversions are used, new diversions should probably be built. New canals should be built that have capacity to deliver water to all of the land under the system. Some of these will need to be lined Some control structures will be needed for regulation. Measuring facilities will be needed for proper distribution.

More should be known about the magnitude of the problems and needs. Studies should be made at a preliminary level to determine those areas and items which should be improved first. Seepage studies will need to be made on some canals to determine those areas of highest losses before corrections can be devised. Equipment and trained personnel will be needed to carry on with this large job.

Instructions and training should be given to the farmers and water users in the proper use of water.

An evaluation should be made of those canals not provided with facilities to by-pass sediment laden flood flows from outside their distribution system. This evaluation should be to determine if the incorporation of the needed facilities into the system would be worth the cost.

In some areas farmers do not irrigate at night and simply turn the irrigation stream into the drains or wasteways where it is lost to other users in the area and often causes additional drainage and water-logging problems. Irrigation ditches are used to deliver water to livestock and villages. This water adds to the already serious drainage problem in many areas, reduces the "down time" required for proper maintenance of the systems, and wastes water

during the growing season that could be used in other areas

Current irrigation water management practices have evolved over the centuries through use, the "hard way" out of necessity. Only recently have modern and more efficient methods been introduced in the area. The practices have come in the main part through or have been associated with large project areas. However, the old traditional methods still prevail in much of the project areas as well as out of these areas. Generally, the farmer is accustomed to having access to running water whenever nature supplies it and in as large a quantity and for as long as he desires it. These traditional uses have in effect become almost "water rights".

Many opportunities exist for improved water management in the Helmand River Basin, both on-farm and in the canal systems. Improvements cannot be made in all areas at once, nor can they be made in a short period of time. Water management must be a continuing effort by all concerned, including the farmer, extension agents, technical people, and other officials of HAVA and the GOA. Much can be accomplished in the proper and best use and development of the water resources if all means of improving water use and management are applied at the same time.

The farmer should understand why proper water management is

important by realizing that he can produce as much and sometimes more with less water while at the same time releasing water to be used in other places. In some places the proper management or use of water may have to be imposed on the user, since not everyone will understand or agree with using less water.

Even in the larger type systems where storage is available, supplies fluctuate considerably from year-to-year and the irrigation water supply is unstable. In those areas relying on streamflow only, seasonal supply variations are more pronounced and cause considerable problems in diverting the water from the river and maintaining a steady supply. New diversions will provide a more stable water supply. They will release the farmers to spend more time farming and less time repairing the diversions. Also, new diversions will allow better control of the water supply and help prevent unauthorized diversion of water.

D. Sedimentation - Both Kajakai and Arghandab Reservoirs should have their current stage-capacity relationship verified.

In order to determine the current stage-capacity relationship, the reservoirs should be resurveyed at the earliest possible time.

It would be desirable to resurvey before any major change is made

in reservoir operations so as to obtain data on previously existing conditions. In the case of Kajakai Reservoir a major change would include the installation of the spillway gates.

The sediment yield to Kajakai and Arghandab Reservoirs is excessive and might be reduced by the installation of a land treatment program.

An erosion and sediment yield survey of the watersheds above the reservoirs should be made to determine the amount, location and type of treatment necessary and its potential effect on sediment yield. For planning purposes, expansion of selected sample watersheds will be sufficient to determine the general treatment needs and cost. To determine the exact needs and location of each practice will require on-site surveys.

Because the major erosion source within the basin is from streambanks and gullies, the most effective method of reducing erosion and sediment yield is by structural measures. They are expensive and may not carry a favorable cost-benefit ratio. Land treatment can be a very effective treatment for sheet erosion, the secondary type in the basin. Control of sheet erosion will not have as great an effect on reduction of sediment yield as the control of streambank and gully erosion but it could cause a significant reduction at considerably less cost.

Debris basins constructed in the watersheds above Kajakai and

Arghandab Dams will only temporarily reduce sedimentation in these major reservoirs. Debris basins will only be effective until they fill with sediment but they can and do fit into a program of treatment. They will start to trap sediment as soon as completed and will provide protection to the major reservoirs until the more effective and longer lasting land treatment and structural measures program can become effective. A detailed cost-benefit analysis should be made to determine the feasibility and desirability of installation of any large debris basins on the main stem or tributaries.

E. Ground Water - Insufficient data are available to predict the location, quantity, and quality of the ground water resource or the effect pumping or importation of surface water might have on it.

A basin-wide ground water study should be undertaken to acquire ground water data necessary for orderly development of the total water resource.

The study should incorporate both shallow and deep ground water investigations. The shallow ground water study would include an inventory of existing wells, karezes, and springs with information on location, yield, depth to watertable, depth of well, and nature of spring occurrence. The deep ground water study should be a program of deep well drilling, testing, and monitoring. The basin-

wide study will not only furnish data on total withdrawal but will furnish information which will make it possible to predict the location, quantity, and quality of ground water. Also, predictions can be made from this data on the effect of pumping or importation of water and the advantages can be weighed against the disadvantages.

Orderly development of the ground water resource requires that essential data be available before development or planning for development occurs. Since these investigation programs are time consuming, it would be desirable to start these soon in order to have the data on hand when conditions are favorable for ground water development.

CHAPTER 5

LAND USE AND MANAGEMENT

Contents

shown on Figure 2-3. Table 2-1 points out an interesting item. Nearly 63 percent of the basin is in the Mountains Resource Area, yet this is the area about which the least is known.

Table 2-1 Resource Areas of the Helmand River Basin by Area and Percent

Resource Area	Square Kilometers	Square Miles	Percent
Mountain	73,963	28,557	62.92
Desert Upland	28,987	11,192	24.66
Desert Plains	14,600	5,637	12.42
Total	117,550	45,386	100.00

A. Mountains Resource Area - This area is largely rugged terrain made up of steep mountains and narrow valleys with discontinuous flood plains. Exposed rocks are mostly limestone although local areas of extrusive or intrusive material occur. Elevations range from 5,102 m (16,740 ft) to about 1,500 m (4,900 ft). Slopes range from about one percent in the valleys to nearly vertical in the mountains. Precipitation ranges from more than 350 mm (14.0 in) to 230 mm (9.1 in). Almost all the runoff for the basin originates from this area, and it comes in the form of snow and rain during the period October through May. The length of the growing season ranges from 190 to 80 days. The soils occur on mountain slopes, alluvial fans and narrow floodplains. They are medium to coarse

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CHAPTER 5

LAND USE AND MANAGEMENT

5.1 GENERAL

This chapter is concerned with the use and management of agricultural lands in the Helmand River Basin. The availability of data is cited for the several aspects of the subject. A factual summary of the present status of land use and development is presented. The potential opportunities for improving the agricultural management and productivity of land in the basin are discussed, and conclusions and recommendations that are essential for optimum use of the land and water resources are given.

5.2 AVAILABLE DATA

Many studies and reports concerning soil and water resources are available on the project areas, but data are very limited or nonexistent for all other lands in the basin. Available references are filed with the United States Agency for International Development (USAID), offices in Lashkar Gah, Kabul, and with the Helmand-Arghandab Valley Authority (HAVA). Available data are discussed under the subjects of land use, crop production, cultural practices, irrigation, drainage and leaching, special practices, and farm size and tenure.

A. Land Use - Many references which contain data on land use for the

project areas were reviewed. Very little information concerning land irrigated from karezes and springs, and for the area of grazing land is available.

B. Crop Production - A limited amount of information is available at the Helmand-Arghandab Valley Authority (HAVA), in the form of crop yield summaries.

C. Cultural Practices - Information concerning the needs and recommendations for cultural practices is available in several references. Much of this information is based upon comparisons with similar conditions in other countries. Evaluation data for most cultural practices are not available.

D. Irrigation - On-farm irrigation water management data are very limited. Some data are available on the location of irrigated areas, and various references contain estimates on over-all irrigation efficiencies. Some estimates have been made on the land irrigated in 1950, as compared to 1974.

E. Drainage and Leaching - Numerous investigations have been made in the project areas, and reports written on drainage and leaching needs. Estimates of total percentage of project areas in need of drainage and leaching have been made.

F. Special Practices - Some data was available in references on special practices, such as erosion control and land leveling.

G. Livestock - Data concerning livestock numbers and monetary value are limited to a few project evaluation studies, such as the Asian Development Bank Report.[2/] No information is available concerning the numbers and composition of herds and flocks on the grazing land.

H. Farm Size and Tenure - Available data concerning farm size and tenure is based upon statistical sampling of ten irrigated areas.

5.3 PRESENT CONDITION

Information presented in this section is based on the review of numerous written reports compiled during the past 25 years by many specialists representing a wide variety of disciplines. Field trips by the study team to many of the cropland areas of the Helmand River Basin supplemented the data contained in the references. The subject matter is presented in the broad categories of land use, crop production, cultural practices, irrigation, drainage and leaching, special practices, livestock, and farm size and tenure.

A. Land Use - Although land has many uses, only the major uses for irrigated land and grazing land are discussed. Land used for roads, villages, towns, non-irrigated crops, canals, drains, reservoirs, mining, and industry is estimated to be small and the amounts were

not determined.

1. Irrigated Land - The estimated total of irrigated land in the Helmand River Basin in 1974 was 200,300 ha (495,000 ac). This total includes an estimated 37,640 ha (93,000 ac) of land irrigated by water from karezes and springs. A summary of irrigated land is given in Table 5-1. The location of the irrigated land where data is available is shown in Figure 5-1.

Irrigated land is estimated to have increased 87 percent or 93,400 ha (230,000 ac) from 1950 to 1974, following construction of the Kajakai and Arghandab Reservoirs. In the same period, the season-long water supply provided by these reservoirs is largely responsible for an estimated increase of summer crops, from 15,800 ha (39,000 ac) to 81,000 ha (200,000 ac). This is an increase of over 400 percent.

Included in the irrigated land is a forest area of about 2,430 ha (6,000 ac) in the East Marja project. Trees were planted on this area, about 1960, to provide wood pulp for a proposed paper manufacturing plant. However, the trees generally appear to have a very slow growth rate, possibly because of the slow and limited growth characteristics of the species of trees that were planted, and also because of competition from the heavy undergrowth of shrubs and grasses. The area is a refuge for wild hogs and birds that cause damage and destroy the

Table 5-1 Estimated Irrigated Lands, Helmand River Basin, 1951 and 1974 - In 1,000 hectares[a]

Location or Source	Irrigated Prior 1951 Total ha (ac)	Irrigated Prior 1951 Summer Crops ha (ac)	Irrigated 1974 Total ha (ac)	Irrigated 1974 Summer Crops ha (ac)
Helmand River[b]				
Boghra System	10.1	1.7	48.4	31.8
	(25.0)	(4.1)	(119.5)	(78.5)
Other Lands	20.5	3.6	48.9	13.9
	(50.5)	(9.1)	(121.0)	(34.5)
Sub-Total	30.6	5.3	97.3	45.7
	(75.5)	(13.2)	(240.5)	(113.0)
Arghandab River[b]	33.8	8.5	54.8	29.3
	(83.5)	(20.9)	(135.4)	(72.3)
Miscellaneous Lands[c]	42.5	2.0	48.2	6.0
	(105.0)	(4.9)	(119.3)	(14.7)
Basin Total[d]	106.9	15.8	200.3	81.0
	(264.0)	(39.0)	(495.2)	(200.0)

a Value in parentheses in 1,000 acres.

b Source, reference.6/

c Estimates compiled by the study team.

d Includes an estimated 37,640 ha (93,000 ac) irrigated by water from karezes and springs.

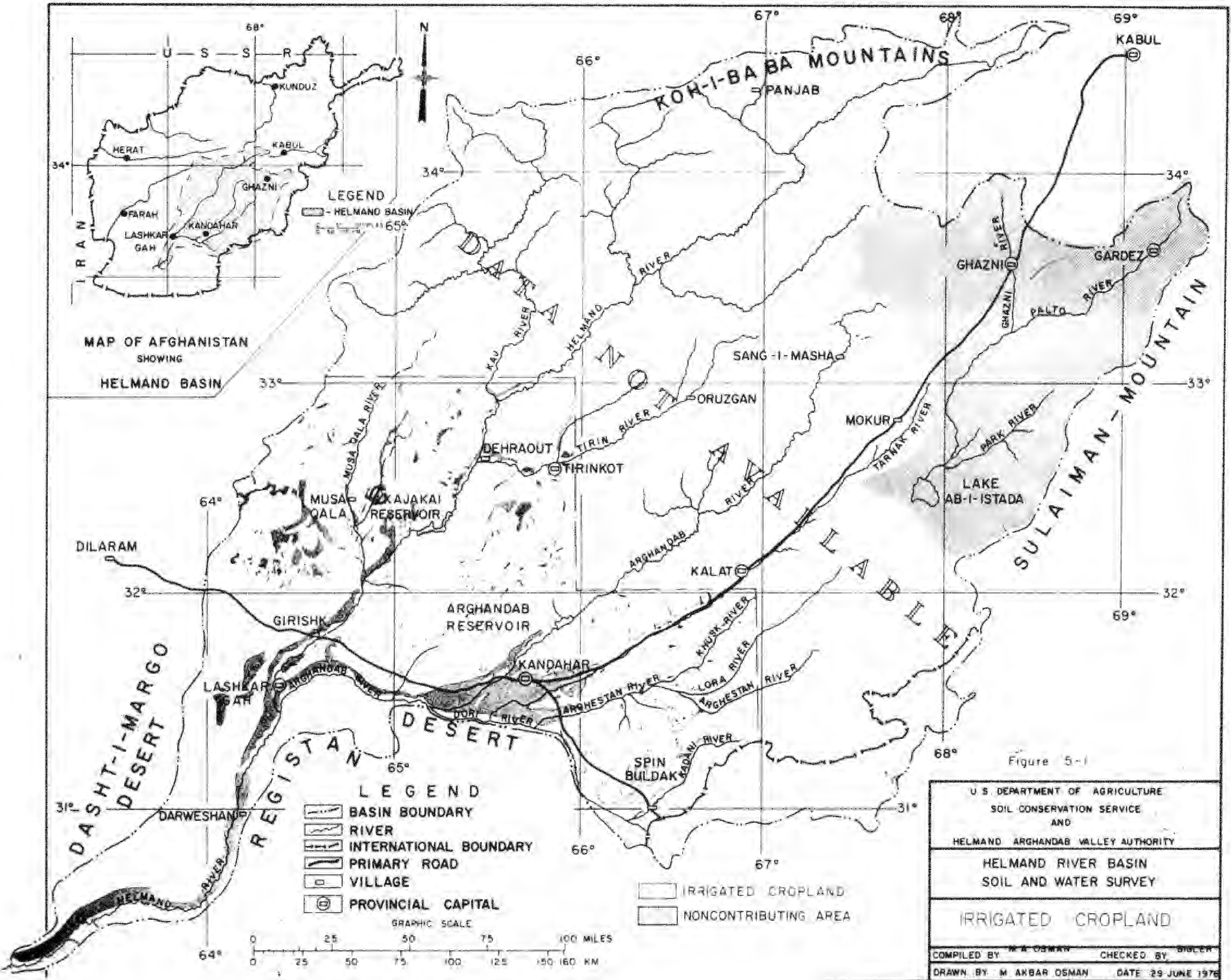
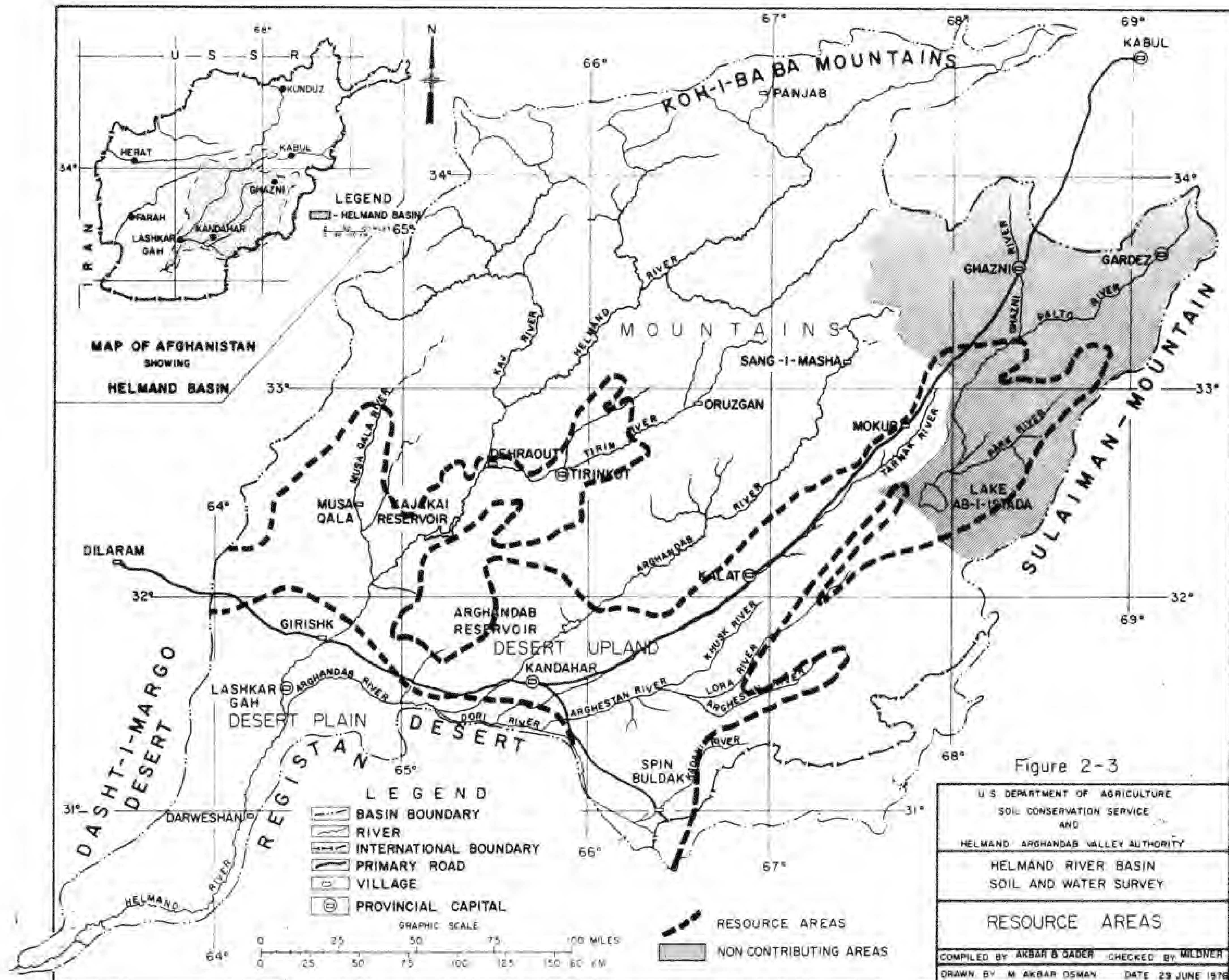

MAP OF AFGHANISTAN
SHOWING
HELMAND BASIN
U S S R
IRAN
KUNDUZ
HERAT
KABUL
GHAZNI
FARAH
KANDAHAR
LASHKAR GAH
LEGEND
HELMAND BASIN
KOH-I-BABA MOUNTAINS
PANJAB
KABUL
GHAZNI
GARDEZ
SULAIMAN-MOUNTAIN
DATA NOT AVAILABLE
SANG-I-MASHA
ORUZGAN
MOKUR
LAKE AB-I-ISTADA
DEHRAOUT
TIRINKOT
MUSA QALA
KAJAKAI RESERVOIR
DILARAM
KALAT
ARGHANDAB RESERVOIR
GIRISHK
KANDAHAR
LASHKAR GAH
DESERT
REGISTAN
DASHT-I-MARGO DESERT
DARWESHAN
SPIN BULDAK
HELMAND RIVER
KAJ RIVER
MUSA QALA RIVER
TIRIN RIVER
ARGHANDAB RIVER
TARNAK RIVER
PARK RIVER
PALTO RIVER
GHAZNI RIVER
KHUSK RIVER
LORA RIVER
ARGHESTAN RIVER
DORI RIVER
KADANI RIVER
L E G E N D
BASIN BOUNDARY
RIVER
INTERNATIONAL BOUNDARY
PRIMARY ROAD
VILLAGE
PROVINCIAL CAPITAL
GRAPHIC SCALE
0 25 50 75 100 MILES
0 25 50 75 100 125 150 160 KM
IRRIGATED CROPLAND
NONCONTRIBUTING AREA
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AND
HELMAND ARGHANDAB VALLEY AUTHORITY
HELMAND RIVER BASIN
SOIL AND WATER SURVEY
IRRIGATED CROPLAND
COMPILED BY M.A. OSMAN CHECKED BY BIGLER
DRAWN BY M AKBAR OSMAN DATE 29 JUNE 1976

Figure 5-1



MAP OF AFGHANISTAN
SHOWING
HELMAND BASIN
U S S R
IRAN
KUNDUZ
HERAT
KABUL
GHAZNI
FARAH
LASHKAR GAH
KANDAHAR
LEGEND
- HELMAND BASIN
N
KOH-I-BABA MOUNTAINS
PANJAB
KABUL
GHAZNI
GARDEZ
MOUNTAINS
SANG-I-MASHA
ORUZGAN
MOKUR
LAKE AB-I-ISTADA
SULAIMAN - MOUNTAIN
DEHRAOUT
TIRINKOT
TIRIN RIVER
HELMAND RIVER
KAJ RIVER
MUSA QALA RIVER
MUSA QALA
KAJAKAI RESERVOIR
DILARAM
GIRISHK
ARGHANDAB RESERVOIR
DESERT UPLAND
KALAT
KANDAHAR
LASHKAR GAH
ARGHANDAB RIVER
ARGHESTAN RIVER
LORA RIVER
KHUSK RIVER
TARNAK RIVER
GHAZNI RIVER
PALTO RIVER
DORI RIVER
DESERT PLAIN
REGISTAN DESERT
DASHT-I-MARGO DESERT
SPIN BULDAK
DARWESHAN
HELMAND RIVER
LEGEND
BASIN BOUNDARY
RIVER
INTERNATIONAL BOUNDARY
PRIMARY ROAD
VILLAGE
PROVINCIAL CAPITAL
GRAPHIC SCALE
0 25 50 75 100 MILES
0 25 50 75 100 125 150 160 KM
RESOURCE AREAS
NON CONTRIBUTING AREAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AND
HELMAND ARGHANDAB VALLEY AUTHORITY
HELMAND RIVER BASIN
SOIL AND WATER SURVEY
RESOURCE AREAS
COMPILED BY AKBAR & QADER CHECKED BY MILDNER
DRAWN BY M AKBAR OSMAN DATE 29 JUNE 1976
64° 65° 66° 67° 68° 69°
31° 32° 33° 34°

Figure 2-3

irrigated crops bordering the area. The area is irrigated by water from the Boghra Canal. A drainage system is partially installed, the soils have been surveyed, and the land classified. Seventy percent of the area is presently classified as being suitable for irrigated crop production. The remaining 30 percent would probably require reclamation by leaching of excess salts before crops could satisfactorily be grown.

2. Grazing Land - This is the vast rain-fed area grazed by sheep, goats, cattle, camels, and donkeys. Vegetation is generally sparse and consists mainly of short shrubs, grasses, and forbes. A more detailed vegetative description is given in Chapter 2 of this report. Production is extremely low and improvement is not easy to achieve because of the traditional system of uncontrolled grazing, which does not allow for sufficient regrowth of vegetation during the growing season.

Included with the grazing land are several thousand hectares of land in the Desert Upland and Mountains Resource Areas that are seeded occasionally to rain-fed wheat. There is no record of the actual extent of this land. Precipitation is low and unpredictable, and is only sufficient to produce a crop on an average of about once in every five years. This land is grazed when crops are not grown.

B. Crop Production - Most crops are grown for food or forage, but some non-food crops are grown such as tobacco and cotton. Crops are also grown to provide seeds for future crop production.

The Helmand River Basin is climatically adapted to a wide variety of crops. The frost-free growing season for the Resource Areas is summarized in Table 2-5. Wheat is the major crop produced and is the most important staple food of the people. It is grown on an estimated 65 percent of the irrigated land. The wide variety of crops and their relative importance in the Helmand Province are shown in Table 5-2a, in hectares and kilograms; and in Table 5-2b, in acres and tons. Cotton has become a major cash crop in recent years in the Helmand Province, having expanded from occupying less than three percent of the irrigated land in 1971, to more than 23 percent in 1974. Grapes are also an important commercial crop, and are eaten both fresh and as raisins.

Orchards and vineyards are widely distributed on the better drained soils that are free of toxic salt problems. Excellent orchards interplanted with alfalfa, clover, wheat, or vegetables are common throughout the basin.

The Kandahar, Musa Qala, and Nowzad communities in the Desert Upland Resource Area are especially well adapted to the growing of a

Table 5-2a Summary of Crop Yields in Helmand Province 1971-74 - Hectares and Kilograms

Crops	1971 Total Land ha	1971 Total Land Percent	1971 Ave. Yield kg/ha	1972 Total Land ha	1972 Total Land Percent	1972 Ave. Yield kg/ha	1973 Total Land ha	1973 Total Land Percent	1973 Ave. Yield kg/ha	1974 Total Land ha	1974 Total Land Percent	1974 Ave. Yield kg/ha	AVERAGE Total Land ha	AVERAGE Total Land Percent	AVERAGE Ave. Yield kg/ha
Wheat, improved	16,886	16.92	3,227	34,544	34.68	3,444	48,308	45.80	2,972	41,294	37.21	3,011	35,258	33.91	3,130
Wheat, local	49,388	49.48	1,219	32,482	32.60	1,734	22,439	21.27	1,823	25,957	23.39	1,752	32,566	31.32	1,558
Corn, improved	2,618	2.62	3,130	5,006	5.03	2,965	2,635	2.50	2,181	1,550	1.40	2,776	2,952	2.84	2,802
Corn, local	13,553	13.58	1,895	14,021	14.07	1,688	5,915	5.60	1,444	3,537	3.18	1,991	9,256	8.90	1,756
Barley	1,494	1.50	1,020	195	0.20	1,323	285	0.27	769	390	0.35	1,350	591	0.57	1,069
Cotton	2,847	2.85	1,304	4,615	4.63	927	11,666	11.06	1,061	26,052	23.47	956	11,295	10.86	990
Vegetables	651	0.65	6,994	744	0.75	11,885	611	0.58	7,238	230	0.21	12,316	559	0.54	9,235
Melons	1,065	1.07	14,058	726	0.73	13,276	3,598	3.41	18,336	1,808	1.63	14,357	1,799	1.73	16,193
Grapes-Fruit	1,837	1.84	7,643	1,503	1.51	10,060	1,999	1.90	8,096	3,549	3.20	9,020	2,222	2.14	5,103
Mung Beans	5,650	5.66	605	2,469	2.48	684	3,642	3.45	723	3,681	3.31	798	3,861	3.71	691
Alfalfa	2,415	2.42	9,981	2,081	2.09	9,353	2,507	2.38	15,484	1,650	1.49	8,007	2,163	2.08	11,048
Clover	837	0.84	9,700	641	0.64	9,900	1,420	1.35	9,553	343	0.31	9,540	810	0.78	9,658
Tobacco	348	0.35	954	297	0.30	935	130	0.12	659	86	0.80	1,015	215	0.21	909
Peanuts	57	0.06	1,238	-	-	-	3	0.01	1,763	18	0.01	431	20	0.02	1,072
Sesame	7	0.01	1,311	163	0.16	502	107	0.10	440	723	0.65	525	250	0.24	518
Rice	70	0.07	2,569	122	0.12	2,441	206	0.19	2,954	88	0.08	2,626	122	0.12	2,710
Cumin	63	0.06	1,404	13	0.01	228	-	-	-	-	-	-	19	0.02	1,203
Other Crops	15	0.02	-	-	-	-	3	0.01	1,398	32	0.03	2,131	13	0.01	1,448
Total	99,801	100%	-	99,622	100%	-	105,475	100%	-	110,986	100%	-	103,971	100%	-

Table 5-2b Summary of Crop Yields in Helmand Province 1971-1974 - Acres and Tons 12/

Crops	1971 Total Land ac	1971 Total Land Percent	1971 Ave. Yield ton/ac	1972 Total Land ac	1972 Total Land Percent	1972 Ave. Yield ton/ac	1973 Total Land ac	1973 Total Land Percent	1973 Ave. Yield ton/ac	1974 Total Land ac	1974 Total Land Percent	1974 Ave. Yield ton/ac	AVERAGE Total Land ac	AVERAGE Total Land Percent	AVERAGE Ave. Yield ton/ac
Wheat, improved	41,725	16.92	1.44	85,358	34.68	1.54	119,369	45.80	1.33	102,037	37.21	1.34	87.123	33.91	1.40
Wheat, local	122,038	49.48	0.54	80,263	32.60	0.77	55,447	21.27	0.81	64,140	23.39	0.78	80,471	31.32	0.70
Corn, improved	6,469	2.62	1.40	12,370	5.03	1.32	6,511	2.50	0.97	3,830	1.40	1.24	7,294	2.84	1.25
Corn, local	33,489	13.58	0.84	34,646	14.07	0.75	14,616	5.60	0.64	8,735	3.18	0.89	22,872	8.90	0.78
Barley	3,692	1.50	0.45	482	0.20	0.59	704	0.27	0.34	964	0.35	0.60	1,460	0.57	0.48
Cotton	7,035	2.85	0.58	11,404	4.63	0.41	28,827	11.06	0.47	64,374	23.47	0.43	27.910	10.86	0.44
Vegetables	1,609	0.65	3.12	1,838	0.75	5.30	1,510	0.58	3.23	568	0.21	5.49	1,381	0.54	4.12
Melons	2,632	1.07	6.27	1,794	0.73	5.92	8,891	3.41	8.18	4,467	1.63	6.40	4,445	1.73	7.22
Grapes-Fruit	4,539	1.84	3.41	3,714	1.51	4.49	4,939	1.90	3.61	8,769	3.20	4.02	5,490	2.14	2.28
Mung Beans	13,961	5.66	0.27	6,101	2.48	0.30	8,999	3.45	0.32	9,096	3.31	0.35	9.540	3.71	0.31
Alfalfa	5,967	2.42	4.45	5,142	2.09	4.17	6,195	2.38	6.91	4,077	1.49	3.57	5,345	2.08	4.93
Clover	2,068	0.84	4.33	1,584	0.64	4.42	3,509	1.35	4.26	847	0.31	4.25	2,001	0.78	4.31
Tobacco	860	0.35	0.42	734	0.30	0.42	321	0.12	0.29	212	0.08	0.45	531	0.21	0.40
Peanuts	141	0.06	0.55	-	-	-	7	0.01	0.79	44	0.01	0.19	49	0.02	0.48
Sesame	17	0.01	0.58	403	0.16	0.22	264	0.10	0.20	1,786	0.65	0.23	618	0.24	0.23
Rice	173	0.07	1.15	301	0.12	1.09	509	0.19	1.32	217	0.08	1.17	301	0.12	1.21
Cumin	156	0.06	0.63	32	0.01	0.10	-	-	-	-	-	-	47	0.02	0.54
Other Crops	37	0.02	-	-	-	-	7	0.01	0.62	79	0.03	0.95	32	0.01	0.65
Total	246,608	100%	-	246,166	100%	-	260,625	100%	-	274,242	100%	-	256,910	100%	-

wide variety of orchard crops, including figs, almond, pomegranates, apricots, peaches, and plums.



Figure 5-2 Pomegranate Orchard Interplanted with Clover

Various crops are grown for seeds on government owned and operated farms. Cotton, watermelon, and improved varieties of wheat are grown at the Gawargi Seed Farm, and sweet corn and other vegetable seeds are produced at the Bolan Farm. Varietal testing is also done at the Bolan Farm. Wheat, corn, and mung bean seeds, in addition to grape and tree nursery stock are produced at Kandahar.



Figure 5-3 Seed Testing at Bolan Farm

Some crops, such as the improved varieties of wheat, are losing many of their superior qualities due to replanting of the same strains year after year. New seed stocks are urgently needed from original sources. A more effective system is needed to maintain the purity of seed stocks. Basic seed stocks need replenishment periodically. More adequate provisions for seed multiplication and distribution are needed.

C. Cultural Practices - The major types of cultural practices affecting crops and crop production are tillage, seeding, harvesting, cropping systems, and soil improvement.

1. Tillage - Most land is plowed with a stick plow drawn by oxen. After the land is plowed, it is smoothed with a "T" shaped drag

that is usually not equipped with harrow teeth. Tillage with modern equipment drawn by a tractor is becoming more common, especially in the project areas. Extension office records indicate that 449 tractors were in use in the Helmand Province in 1975.



Figure 5-4 Tillage with a Tractor

Land used for summer cropping is usually pre-irrigated before plowing to facilitate tillage.

2. Seeding - The broadcast method of seeding is used for most crops. It is usually done by hand. The seed is then covered by plowing or dragging. This seeding method taken much time and labor, and in most instances, requires much more seed than would be needed, if a mechanical drill or a planter was used.

Less seed is required when machines are used, because the seeds are planted at the optimum depth and in the proper spacing.



Figure 5-5 Uneven Stand of Broadcast Seeded Cotton

An increasing amount of cotton and corn is being row-planted by hand on ridges. Extension agents and other crop specialists state that yields are significantly better with row planting than with broadcast seeding.



Figure 5-6 Good Stand of Row Planted Cotton

3. Harvesting - Harvesting of nearly all crops is done by hand. Small grain crops are cut with a small hand sickle, carried to a threshing floor, and threshed by trampling with oxen or by driving over it with a tractor. It is then winnowed to separate the straw, chaff, and dust from the grain. Alfalfa, clover, and corn are also cut with a sickle, and cotton is picked by hand.



Figure 5-7 Harvesting Alfalfa with a Hand Sickle



Figure 5-8 Threshing Wheat by Trampling with Oxen

textured, shallow to deep and have moderate to rapid permeability, and under natural conditions are well or moderately well drained. They are limited in aerial extent but suitable soils are dry cropped where precipitation is adequate and are irrigated where water is available. Scattered patches of trees and shrubs occur and annual grasses and forbes appear after winter and spring precipitation.

B. Desert Upland Resource Area - This area is composed of river terraces and alluvial fan deposits with low hills and mountains. In the lower section isolated mountains rise abruptly from the valley floor. Exposed rocks are mostly limestone, but local areas of extrusive igneous material are also present. The elevation of this area ranges roughly between 1,500 m (4,900 ft) and 900 m (2,900 ft). In the valleys, slopes range from less than one percent to upwards of 25 percent between terraces and in the dissected portions. In the mountain areas, slopes may be nearly vertical. Annual average precipitation ranges from about 230 mm (9.1 in) to 150 mm (5.2 in) and comes in the form of rain and snow during the period November through May. A small amount of the runoff for the basin, perhaps as much as 15 percent, originates in this area. The growing season ranges from 265 to 190 days. The soils are deep, medium textured, moderately permeable to very slowly permeable and under natural conditions well to poorly drained. Orchards and vineyards are common in this

Labor shortage is apparent throughout the basin at harvest time, but is especially critical in the more remote areas. Wheat and cotton crops are especially subject to loss and damage, if not harvested at the proper time.

Most crops are transported from the field and to local markets by donkeys or cart. Buses, trucks, and tractors with trailers



Figure 5-9 Transporting Wheat by Donkey

transport most farm products to more distant markets. Most farm roads are located on canal and drainage ditch banks, and are usually inadequate and poorly maintained. Areas such as Musa Qala, Nowzad, and Tirin, as an example, rely on roads that are impassable by motorized transport part of the year.

Poor roads not only restrict movement of crops, but also restrict transportation of labor to accomplish harvesting at the proper time.

4. <u>Cropping Systems</u> - Cropping systems vary with locality, water availability, soil type, drainage, soil salinity, price fluctuations, and other factors.

The sequence in which crops are grown is generally quite irregular. Few farmers follow long range planned crop rotation systems. Wheat, the most important crop, is seeded in either the fall or the spring. Fall planting requires less irrigation water and yields are usually better. In water-short areas, it is planted every second or third year in a wheat-idle land rotation system. In areas with an adequate water supply, wheat is an annual crop, and is commonly followed by cotton, corn, or mung beans in a double cropping system. Other crops, such as alfalfa, melons, and vegetables, are usually grown either continuously or in an irregular sequence.

Planned conservation cropping systems are being followed on a number of farms. One excellent system observed in the East Marja Project included alfalfa, four or five years, followed by double cropping wheat with cotton, corn, or mung beans, two or three years. Occasionally, clover for livestock feed and soil improvement is

planted rather than wheat. Animal manure is applied at least once in the rotation, and a planned and adequate fertilizer program is followed. Six to 10 inches of wheat stubble was observed, June 6th, being partially incorporated into the soil by the use of a stick plow in preparation for cotton seeding. Wheat and alfalfa fields were weed free, and appeared much more productive than most in the area.



Figure 5-10 Partially Incorporating Wheat Stubble into the Soil with a Stick Plow

This is an excellent example of applying a cropping system that has been recommended repeatedly by agricultural advisors.

5. Soil Improvement - Soils in hot and arid areas are inherently low in organic matter. Crop rotations with soil improving and high residue crops to increase organic matter in the soil have been recommended.[4/] However, very little organic matter is

usually added to the soil, because of the age-old uses of crop residues for fuel, building material, and feed for livestock.

Another soil depleting practice is the burning of stubble. The reason for this is probably to facilitate tillage, and in some instances, to the belief that a significant increase in soil fertility is associated with burning. However, field observations in the summer of 1976, found very little burning of wheat stubble, perhaps indicating that this practice is decreasing. Alfalfa and clover have been recommended repeatedly, and are now being planted on a considerable area.[12/]

The use of nitrogen and phosphate fertilizers is a proven and growing practice contributing to significant yield increases. Fertilizer is distributed by the Afghan Fertilizer Company (AFC), which is a government enterprise that manfactures urea and distributes fertilizer throughout the country. Phosphate fertilizer is imported. Farmers in groups of five or ten are able to get fertilizer credit coupons through the Afghanistan Agricultural Development Bank. The coupons are exchangeable for fertilizer at subsidized prices. This program is very successful and fertilizer usage is increasing. The AFC Regional Office at Lashkar Gah reported that the use of urea nitrogen fertilizer increased from

8,890 Mg (9,800 tons) in 1974 to 13,150 Mg (14,500 tons) in 1975. This is an increase of 48 percent. The application of phosphate fertilizer averaged approximately 4,600 Mg (5,070 tons) for the same year.

Another factor that limits soil improvement is the use of tillage equipment which does not allow for the easy incorporation of soil improving crops into the soil.

D. Irrigation - Most irrigation is done with traditional gravity methods, which vary according to crops and farming practices. Irrigation efficiencies vary widely throughout the basin.

1. Methods - The common methods of irrigation are basin, contour bench terrace, border, and furrow-basin.

- Basin - This is the most common and traditional method of water application. In this method, flat and slightly sloping fields are subdivided into small basins by dikes. Water is released from basin to basin as it proceeds down the field. The labor requirement to build the basins by hand is very high. This system provides effective water control, and can be very efficient if used properly.



Figure 5-11 Basin Irrigation System

- Contour Bench Terrace - This method is used on the more sloping lands for water distribution and erosion control. In this method, water is released into the benches from a jui or field ditch The benches are usually subdivided into basins by dikes.

- Border - This method is adapted for use on the same lands as is the basin method. In this method, borders or small dikes are generally spaced five to ten meters (19 to 33 ft) apart, and are up to 100 m (328 ft) or more in length. This method could be encouraged to increase efficiency of water application and save labor in some places. However, this

method would probably require land leveling or smoothing on most fields before it could be efficiently applied.

- Furrow Basin - In this method, a combination of furrows and basins are used for irrigating row-planted cotton, corn, melons, cucumbers, squash, and tomatoes. Deep furrows are excavated within the basin to form ridges, on which the crop is seeded in rows. Most ridging is done by hand labor. The ridges are usually spaced 800 mm (32 in) apart for cotton and corn planting.



Figure 5-12 Furrow-Basin Irrigation System

2. On-farm Water Application Efficiency - The amount of water applied to crops varies widely throughout the Helmand River Basin.

Usually where more water is available, more is used. The number of irrigations for wheat may vary from two to five or more depending upon water availability. Much more water is generally applied with greater loss to runoff and deep percolation in the project areas, where water is abundant, than in areas where water is in short supply.[6/] For instance, the efficiency of irrigation water use on some fields in the Nad-i-Ali Project was estimated to be less than 25 percent with applications of 125 mm (5 in) of water when only 50 mm (2 in) were required by the crop.[13/] This excessive application reduces crop yields by water logging the soil and leaching plant nutrients. In contrast, the efficiency of irrigation water use is fair to good and is estimated to be 50 percent or more in areas of short water supply, as evidenced by a minimum of surface runoff and drainage problems. Poor irrigation efficiency is due to many factors, some of which are as follows:

- Poor designed distribution systems without control structures or measuring devices.

- Ineffective systems of water allocation from farm to farm. Often, the farmer nearest the source gets more water than his fair share.

- Reluctance of farmers to irrigate at night in some of the

more water-abundant areas. The water is turned down the drains and wasteways when not being used.

- Lack of knowledge of soil and plant relationships to the amount of water used. Many farmers do not know the water holding capacity of the soil and the water requirement of the crop, and do not realize that using too much water may be more harmful than using too little.

- Unlevel and poorly prepared fields.

E. Drainage and Leaching - As cited in the preceding topic, drainage problems develop when more water is applied than is needed by the crop, especially in soils underlain by restrictive layers of clay, hardpan, or conglomerate. For these reasons, severe drainage problems developed in the Nad-i-Ali and Marja areas and caused many farms to be abandoned shortly after settlement. Many other areas in the basin have drainage problems in varying degrees of severity. An estimated 35 percent of the irrigated land in the Helmand River Basin was believed to need drainage in 1956.[4/]



Figure 5-13 Excavating a Drainage Channel

Leaching is the process of applying extra irrigation water to remove harmful salts from the soil. Soils within the basin contain considerable salts. Irrigation, associated with inadequate drainage, tends to concentrate these salts on or near the soil surface. This condition has developed on portions of the project areas, and is present to a lesser extent in other areas. Gypsum should be applied on soil with a high sodium content prior to leaching. However, little or no gypsum has been applied. The completion of the improved drainage systems, now under construction on some project areas, should result in more effective leaching.

area on the better soils. The non-irrigated area is used for grazing by the herds owned by the nomadic tribesmen and to a limited extent for cropland. Desert shrubs are scattered over the landscape and annual grasses and forbes appear after the winter and spring rains.

C. Desert Plains Resource Area - This area is composed of several levels of river terraces, and prominent alluvial valleys. The surface of the alluvial material is relatively flat and smooth.

The elevation of this area ranges roughly between 900 m (2,900 ft) to about 570 m (1,870 ft). Slopes range from less than one percent upward to 25 percent between terraces and in the dissected portions. Average precipitation ranges from 150 mm (5.2 in) to 70 mm (2.8 in) and comes in the form of rainstorms during the period November through April. An extremely small portion of the runoff of the basin originates in this area and is characterized by high flows of short duration and low volume. The length of the growing season ranges from more than 280 days to 265 days. Watershed boundaries are indistinct and flood plains are poorly defined. The dominant soils of the high terraces are gravelly, moderately fine textured, moderately deep to shallow, mostly slowly permeable, and under natural conditions are well drained and moderately well drained. The surface of these terraces may be covered by dune material. The dominant soils of the low terraces are medium textured, deep and moderately

There is a rather general belief in the basin, that the quantity of irrigation water supplied should always be in excess of the needs of the crop, to prevent a build-up of salts in the soils. This belief may, or may not be true, depending upon the kind and amount of salt in the soil, and upon the quality of water being applied. Excess water application leaches soil nutrients, aggravates drainage problems, and is counter to the principles of efficient water management. Consequently, the application of more water than the crop needs should be avoided, except under special conditions where leaching of salt is required.

F. Special Practices - Several other practices, in addition to those already discussed, are important to crop production. These include land leveling; erosion control; and weed, insect, and plant disease control.

1. Land Leveling - Some fields have been leveled in the past and require little or no additional leveling. A lack of earth moving equipment, high costs, and lack of engineering expertise are reasons why more land leveling has not been done. Only light leveling and smoothing is required on many fields to achieve more uniform water distribution. Where substantial leveling is required, shallow soils may limit the depth of excavation. The total extent of land leveling needed has not been determined.

2. Erosion Control Measures - Comments in this section are limited

to the erosion of soil by wind and water on cropland. Erosion on the grazing lands of the basin is discussed in Chapter 4, under sedimentation.

- <u>Water Erosion</u> - Some gully and stream bank erosion occurs in connection with irrigation waste water disposal. Deep cuts often occur when adequate structural measures are not provided where water either re-enters the irrigation canals or where it is wasted into drains.

  Erosion does not appear to be a serious problem on most irrigated fields. Most of this land is flat or only slightly sloping, and the common use of basins for irrigation effectively prevents surface runoff from the fields. On the steeper lands, irrigation water is effectively controlled on the fields by using a combination of contour bench terraces and basins.

- <u>Wind Erosion</u> - Blowing and drifting sand is a problem on some irrigated land that is adjacent to the desert dune areas. This type of wind erosion can be reduced by structural and vegetative measures used either singly or in combination.

  An example of effectively applying these measures in combination is the sand barrier protecting the East Marja Canal.

This barrier consists of an earthen ridge about 3.0 m (9.8 ft) high and a multi-row windbreak of tamerisk or salt cedar installed and planted on the west or windward side of the canal. The barrier has proven effective over much of its length for over twenty years. Lack of periodic maintenance and care have resulted in deterioration of some sections of the barrier, and sand is drifting into the canal.



Figure 5-14 Wind Erosion Control

Wind erosion is also a serious problem where sand is blown along the ground, leaving behind a concentration of gravel on the surface of the soil as desert pavement or exposing areas of subsoil. The blowing sand also

can cut off tender young wheat seedlings and damage other plants.

This type of erosion can be reduced by plowing and leaving unbroken clods which create an uneven surface. Planting crops in narrow strips perpendicular to the direction of the prevailing winds alternately with well established crops also helps reduce wind erosion. Disturbance of the desert pavement should be avoided, because the gravelly layer protects the surface soil from erosion. Wind breaks can also be an effective means of reducing wind erosion.

3. Weed, Insect, and Plant Disease Control - Weeds, insects, and plant diseases are problems throughout the basins. Crop loss and damage due to these problems have not been measured, but the amount would undoubtedly be significant.

Weed control is done primarily by hand. Timeliness is very important in weed control, and this is difficult to achieve with slow and laborious hand methods.

Bindweed and other noxious weeds are abundant in the fields Aquatic weeds cause serious problems in canals and drains.

Insect control appears to be virtually non-existent. Serious infestations of insects were observed on field crops, orchards, and vineyards.

Fungus diseases, such as mildew, are serious problems on grapes and other crops.

G. Livestock - Livestock plays an important role in the production of crops and utilization of vegetation in the basin. They also provide a quality food product.

1. Production - The number of livestock in 1970 in the Helmand Province, not including the nomad herds, is shown in Table 5-3. Of particular note are the statistics concerning cattle. There are nearly 24,000 milk cows of local breeds and about 1,000 head of improved breeds. More cattle are used for draft animals than are kept for milk production. Table 5-4 shows the value of livestock production and sales.

The majority of livestock are now owned by nomads. If more irrigated forage crops were grown, an increase in the number of farm livestock would be expected.

2. Feed Supplies - The sources of feed for most of the livestock are the grazing lands, non-cultivated areas bordering fields, and the crop residues left after harvest. Legumes grown on the irrigated cropland are becoming more important as livestock feed. They are usually cut by hand and carried to the livestock, and fed

Table 5-3 Number of Livestock by Area, Helmand Province, Not Including Nomad Herds, 1970 2/

Area	Milk Cows		Sheep	Goats	Chickens		Other Fowl	Oxen	Donkeys	Horses	Camels
	Local	Improved			Local	Improved					
Nad-i-Ali	1,713	175	2,025	1,149	6,133	136	-	2,765	1,850	78	-
Marja	818	82	3,297	1,777	2,630	292	-	1,111	877	23	234
Shamalan	6,865	269	7,802	303	23,306	101	-	5,347	2,926	370	370
Darweshan	1,754	301	8,769	381	4,346	46	-	1,937	2,318	76	564
Khanashin	534	-	8,408	1,116	1,156	-	-	1,514	1,211	80	773
Seraj	2,248	-	1,047	2,233	4,913	-	92	2,495	1,540	-	323
Girishk	2,727	173	7,974	621	7,111	1,070	1,070	3,487	2,589	207	276
Sangin-Kajakai	3,874	65	4,358	775	11,169	-	129	3,777	3,583	65	-
Musa Qala-West Kajakai	2,399	-	12,844	743	8,662	-	-	2,081	2,250	382	106
Nowzad	572	-	5,862	1,657	1,628	-	48	688	717	48	126
TOTAL	23,504	1,065	62,386	10,755	71,054	1,654	1,339	25,202	19,861	1,329	2,772

Table 5-4 Value of Livestock Production and Sales by Area, Helmand Province, Not Including Nomad Herds, 1970 2/ (in 1000 Afs)

Area	Value of Production				Values of Sales
	Milk Cows	Sheep & Goats	Hens	Total	Livestock
Nad-i-Ali	3,682	590	500	4,772	302
Marja	1,755	934	234	2,923	6
Shamalan	13,546	1,604	1,402	16,552	1,251
Darweshan	3,479	1,679	348	5,506	398
Khanashin	1,041	1,762	92	2,895	192
Seraj	4,414	533	393	5,340	819
Girishk	5,654	1,590	570	7,814	1,911
Sangin-Kajakai	7,679	949	894	9,522	184
Musa Qala-West Kajakai	4,677	2,526	692	7,895	603
Nowzad	850	1,321	126	2,297	37
TOTAL	46,777	13,488	5,251	65,516	5,703

green or as hay during the winter months. Very little grass is presently planted on irrigated land.

3. Management - Livestock are closely herded at all times. Grazing continues as long as feed is available. The nomads move their herds to follow the green vegetation from the desert in early spring to the high elevations in summer. Continuous overgrazing has lowered the production of the grazing land, and it makes any permanent improvement in the productivity of the land difficult.

Many centuries ago, before herding of domestic livestock, the grazing lands were probably covered by tall bunch grasses. Continuous grazing by livestock have largely eliminated these bunch grasses, and they have been replaced by the present short grasses and thorny plants that are able to survive heavy use.

H. Farm Size and Tenure - Tenure of land by number and percent based upon a sampling of farms in 1970 is shown in Table 5-5 for a part of the Helmand River Basin. It is assumed that the tenure may be similar in other areas not included in the table. It is interesting to note, that the majority of farm operators are also owners. This is considered desirable, because a land owner usually has a stronger incentive for conserving and improving his land, than do tenant farmers

who do not have a long time financial investment in the land.

The size of farming units is an important factor because of its effect on the ability of the operator to make improvements in his farm operation. Farms should be of sufficient size and productivity to provide the operator and his family with adequate income for a reasonable standard of living and for the necessary improvements on the farm. Farmers who do not have farms of the size and productivity to be a viable economic unit usually must find other employment. This may cause the farm operation to become neglected. Improper timing of plowing, planting, harvesting, weed control, and water application are more likely to happen in a part-time farm operation than in a full-time operation.

Average farm size is shown in Table 5-6, and percent distribution of farm size by area is shown in Table 5-7. Farm sizes vary from 2.51 ha (6.2 ac) in the Sangin-Kajakai area to 26.95 ha (66.6 ac) in Khanashin. The average size of farm in the project areas of Nad-i-Ali, Marja, Shamalan, and Darweshan range between 8.53 ha (21.1ac) to 5.49 ha (13.6 ac), and the average amount of cropland per farm is between 7.54 ha (18.6 ac) to 4.43 ha (10.9 ac).

Table 5-5 Farm Tenure Classification for Ten Selected Areas, Helmand Province, 1970 2/

Area	Owner-Operators No.	Owner-Operators %	Part Owners No.	Part Owners %	Keshteqars[a] No.	Keshteqars[a] %	Bazqars[b] No.
Nad-i-Ali	38	90.5	2	4.8	2	4.8	26
Marja	35	87.5	2	5.0	3	7.5	7
Shamalan	59	90.8	1	1.5	5	7.7	49
Darweshan	31	72.1	4	9.3	8	18.6	42
Khanashin	22	50.0	-	-	22	50.0	56
Seraj	43	91.5	3	6.4	1	2.1	44
Girishk	44	84.6	4	7.7	4	7.7	61
Sangin-Kajakai	47	87.1	5	9.2	2	3.7	16
Musa Qala-West Kajakai	59	95.2	3	4.8	-	-	44
Nowzad	35	92.1	1	2.6	2	5.3	18

a Tenant farmers who supply labor and other inputs and are involved in decision making.

b Tenant farmers who supply labor only.

Table 5-6 Average Farm Size for Ten Selected Areas, Helmand Province, 1970 2/

Area	Average Farm Size Ha	Average Farm Size Ac	Cropland per Farm Ha	Cropland per Farm Ac
Nad-i-Ali	6.89	17.0	4.72	11.7
Marja	5.89	14.6	5.39	13.3
Shamalan	5.49	13.6	4.43	10.9
Darweshan	8.53	21.1	7.54	18.6
Khanashin	26.95	66.6	18.19	44.9
Seraj	10.79	26.7	6.07	15.0
Girishk	7.39	18.3	5.33	13.2
Sangin-Kajakai	2.51	6.2	1.89	4.7
Musa Qala-West Kajakai	7.74	19.1	2.92	7.2
Nowzad	7.47	18.5	2.95	7.3

deep, moderately permeable, and under natural conditions are well drained and moderately well drained. The soils on the lower terrace are well suited to irrigated agriculture, while suitability of soils on the upper terraces are limited because of excessive gravel and slow permeability. Non-irrigated agriculture is limited to seasonal grazing by herds of camels, sheep and goats owned by nomadic tribesmen. Desert shrubs exist and a sparse growth of short perennial and annual grasses and forbes are seen after winter and spring rains.

2.3 CLIMATE

The climate of the Helmand River Basin is hot and very arid, particularly at the lower elevations where precipitation is scant. Summers are hot especially during June and July. In the lower section of the basin, maximums of above 52 ^{o}C (126 ^{o}F) have been reported. The winters are mild with minimum temperatures usually not below freezing. However, minimum temperatures go below freezing long enough and often enough to make the growing of tropical and sub-tropical plants such as citrus, dates, and bananas impractical. In summer, the days are bright and sunny. Cloudy days generally occur during the winter.

One adverse climatic phenomenon of the Helmand River Basin is the sand and dust storms which may occur at any time throughout the year, but are most common in spring and fall. These storms are usually of local origin, and are caused by winds which sweep along and pick up sand particles from

Table 5-7 Percent Distribution of Farm Size for Ten Selected Areas, Helmand Province, 1970, in Hectares 2/*

Area	0-0.49 (0-1.2)	0.50-0.99 (1.2-2.4)	1.0-1.99 (2.5-4.9)	2.0-2.99 (4.9-7.4)	3.0-3.99 (7.4-9.9)	4.0-5.99 (9.9-14.8)	6.0-9.99 (14.8-24.7)	10.0-19.99 (24.7-49.4)	20.0-99.99 (49.4-247.1)	100 (247.1)
Nad-i-Ali	-	-	-	2.4	7.1	28.6	45.2	14.3	2.4	-
Marja	-	-	-	2.5	2.5	57.5	25.0	12.5	-	-
Shamalan	-	1.6	11.3	19.6	17.7	17.7	8.0	17.7	6.4	-
Darweshan	-	10.0	12.5	5.0	15.0	22.5	10.0	15.0	10.0	-
Khanashin	-	-	2.5	-	-	12.5	17.5	47.5	15.0	5.0
Seraj	2.1	6.4	8.5	8.5	17.0	10.7	17.0	19.2	8.5	2.1
Girishk	-	8.0	16.0	26.0	18.0	12.0	2.0	6.0	12.0	-
Sangin-Kajakai	-	22.2	27.8	24.1	11.1	5.6	7.4	-	-	1.8
Musa Qala-West Kajakai	1.6	1.3	14.5	24.2	8.1	6.4	17.7	8.1	6.4	1.7
Nowzad	13.1	15.8	18.5	7.9	2.6	5.3	13.1	15.8	7.9	-

* Values in parentheses are in acres.

5.4 IMPROVEMENT POTENTIALS

This section summarizes the potentials for developing additional irrigated land, and for improving production on both the irrigated cropland and the grazing land. The potentials are cited for producing a number of crops, not presently grown in the basin, and for improving irrigation water management and drainage systems on irrigated lands.

A. Land Use - Future expansion of irrigated land in the Helmand River Basin is anticipated to more fully utilize available soil and water resources. Good soils exist on sizeable areas of grazing land, and it is anticipated that any expansion of irrigated land will take place on these areas.

There may be potential for establishing forests in the Mountains Resource Area where favorable soils and climatic conditions prevail.

As described previously, the forest area in the East Marja Project appears relatively unproductive in its present use. Conversion to irrigated cropland may be a more profitable and appropriate use for this land. Settlement of up to 400 families could be achieved over a period of several years. Development would include the clearing of trees, installing the farm irrigation water distribution and drainage systems, reclamation, and plowing of the land for the first time. This preliminary land preparation would probably have to be done by heavy mechanized

equipment. A part of the develoment cost of the project could possibly be recovered by sale of the wood products.

B. Crop Production - Although some farmers are achieving good yields of all crops on irrigated land, most yields are only poor and are far below their potential. It is estimated by the study team, that yields could be increased an average of 100 percent or more, by planting improved varieties and using improved cultural and irrigation practices.

Wheat is an excellent example of the effect of varietal selection on yields. Data in Tables 5-2a and 5-2b indicate that average yields are 100 percent higher for improved wheat varieties than for the unimproved or local varieties. Yields of improved varieties of corn were 60 percent higher than for local varieties. The yields of other crops may be expected to increase accordingly, if new and improved varieties were used. Yields of most crops could be increased by an estimated 50 percent, or more, by improving cultural practices.

There are many crops in addition to those regularly grown, which may have potential. Some of these are presently being tested at the Bolan Farm. Many more crops have had limited trials in past years.[10/] Field and orchard crops which may have a potential for export and local use include:

Sugar beets	Flax
Sweet potatoes	Oats
Sunflower	Olives
Safflower	Hemp
Castor beans	Knaf

Some potential forage and soil building crops include:

Huban (annual sweet clover)	Rhodes grass
Bi-annual sweet clover	Berseem clover
Orchard grass	Sudan grass
Tall fescue grass	Birdsfoot trefoil
Tall wheat grass	Dallas grass

Some of these plants, such as tall wheat grass, are especially adapted to certain difficult growing conditions. Tall wheat grass has a high tolerance of salty conditions.

Forage production on grazing land could be improved by applying effective systems of grazing management and seeding areas that have favorable soil and moisture conditions to adapted grasses. Much of the marginal land being used as cropland on an intermittent basis would be more productive if it were seeded to grass and used as grazing land. On favorable areas where rainfed crops are grown, good management practices need to be used to improve production.

C. Cultural Practices - Improvement in tillage methods is being achieved by many farmers who use tractors and well designed machinery. This improvement is expected to continue as more tractors and better machines come into use. More special machines for drilling or planting, and harvesting of crops are needed to improve efficiency.

Cropping systems which include a fertility management program build organic matter in the soil for long term soil improvement. Legumes included in a crop rotation may also improve tilth, organic matter, and fertility.

D. Irrigation - Improvement of on-farm irrigation water management and between farm distribution is imperative if maximum production from irrigated land is to be achieved. For gravity irrigation, this would involve the installation of irrigation structures, land leveling, improved methods of water application, and improved regulation of stream flows. It is estimated that application efficiencies of over 60 percent could be achieved with the proper use of the present methods of irrigation. Sprinkler irrigation has proven to be efficient in many parts of the world.

E. Drainage and Leaching - Most of the soils in the basin can be drained and leached after proper drainage systems are installed. Addition of typsum may aid the leaching process. It is estimated that as much as 70,100 ha (173,000 ac) could be benefited by drainage and leaching.

F. Special Practices - Most irrigated land would benefit from land leveling or smoothing. Water erosion control measures and structures are needed on both irrigated and grazing lands to prevent sheet and gully erosion and reduce sediment pollution in streams and reservoirs. Wind barriers would reduce wind erosion in some areas.

Effective weed, insect, and plant disease control eradication programs would greatly enhace both the quantity and the quality of the crops produced.

G. Livestock - There is potential for increasing both the size and quality as well as the number of animals produced. The improvement of herds can be achieved through selective breeding. More and better markets for meat and milk are needed. More and better roads and equipment for transport of livestock and livestock products to market would also help make the production of livestock more profitable.

H. Farm Size and Tenure - Farm units should be of sufficient size to utilize available labor and to provide an adequate income for the farm family.

Government policies concerning the size of farm units will have a significant effect on the success of future irrigation projects.

5.5 CONCLUSIONS AND RECOMMENDATIONS

Conclusions and recommendations are cited in this section. They are discussed under the headings of land use, crop production, cultural practices, irrigation, drainage and leaching, special practices, livestock, and farm size and tenure.

A. Land Use

1. Irrigated Land - The economic feasibility of the continued use of the 2,430 ha (6,000 ac) forest area at Marja for tree production appears questionable. Limited observation indicates that the annual production of wood is low.

   - A study should be made to evaluate the alternative of con-converting this area to irrigated cropland.

2. Grazing Land - Improving the production of the grazing land is technically feasible and should be accomplished. Improvement potential in the Desert Plain Resource Area is limited because of climate.

   - Several study plots or enclosures should be established on different sites on the grazing lands of the Desert Upland and Mountains Resource Areas. These enclosures must be fenced to exclude all livestock. These plots are necessary in order to study and evaluate the effects of controlled and

planned grazing on the vigor and productivity of the native plants. This knowledge is essential to planning for the future improvement of these lands.

- Trial plantings of adapted grasses should be made on the non-irrigated land on which wheat is seeded occasionally in the Desert Upland Resource Area. Yield samples should be taken annually to evaluate the quantity and value of the forage produced for livestock feed, as compared to the net value of the occasional crop of wheat produced on this land.

B. Crop Production - Crop yields on irrigated land can be increased.

- Varietal and seed testings programs should be intensified.

- The present seed production programs should be evaluated and strengthened as needed to insure the purity, adequate production, and distribution of high yielding disease resistant strains of crops.

C. Cultural Practices - Most cultural practices now being used can be improved.

- The education program to teach the timely application of improved cultural practices should be enlarged and strengthened.

- The use of more effective methods of smoothing, reducing clods, and preparing a good seed bed following plowing should be encouraged.

- The use of more efficient methods of seeding crops to reduce the amount of seed required, improve the plant spacing, and achieve an optimum plant population should be encouraged.

- More labor-efficient methods of harvesting should be encouraged. This is especially needed for wheat.

D. Irrigation - Improvement of on-farm efficiency of irrigation water use needs to be improved. Improvement will require the application of both structural and management practices in addition to an intensive education program with the farmers.

- An education program to train farmers in the techniques of efficient water use should be implemented. This program should include on-farm demonstrations, field days, group meetings, direct individual on-farm assistance, and the development and distribution of visual educational aids.

- Accurate water dividing structures and measuring devices should be installed at the head of all farm irrigation laterals. This would facilitate equitable water delivery and distribution.

- An equitable system of distribution of water between farms must be enforced.

- A more effective program of maintenance should be implemented for the sublateral and farm lateral canals.

- The water application efficiencies of different methods of irrigation should be evaluated.

E. Drainage and Leaching - Poor drainage and the related problem of excess salts are present on many areas in varying degrees of severity. These problems can be reduced by drainage and leaching.

- Existing drains should be cleaned and additional drains installed as the need is indicated by soil and engineering investigations.

- Further studies should be made of the leaching process for eliminating toxic salts from the soil. Steps of the process needing particular attention are water and gypsum requirements for given soil conditions and the quantity of additional irrigation water required, to maintain a non-toxic salt level after the initial leaching process has been effectively completed.

F. Special Practices - Some special practices are needed to achieve the best results from farming irrigated land.

the desert floor. Sometimes these storms severely limit visibility for several hours.

The area can be grouped into three general climatic zones which conform to the Resource Areas. The tables in the following sections are grouped in this manner. Some of the listed stations are outside of the basin, but are felt to represent the climate of the area. Figure 2-4 shows the locations of the meteorological stations used in this report.

A. Air Temperature - As might be expected, the Mountains Resource Area has the lowest temperatures. The mean monthly summer air temperature (June through August averages about 17°C (63°F), and during the winter (December through February) is about -10°C (14°F). The Desert Upland is warmer. During the summer months, the mean monthly temperature is about 25.7°C (78°F) and the mean maximum daily air temperature is 41°C (106°F). The Desert Plain Resource Area, with Lashkar Gah located in the central portion, is among the hottest areas in Afghanistan; the mean monthly air temperature of the summer months exceeds 30°C (87°F). The maximum daily air temperature during the summer may exceed 52°C (126°F). Table 2-2 shows mean monthly temperatures.

B. Precipitation - The Mountains and Desert Upland Resource Areas receive precipitation during the period of November through April in the form of rain or snow. Precipitation in the Desert Plain Resource Area starts about a month later than the higher elevations and occurs only in the form of rain. In this area, it rains during the period December

- Research and investigation to determine usable and effective methods of weed, insect, and plant disease control should be strengthened.

- Land leveling and smoothing should be accomplished where needed.

G. Livestock - The herds and flocks can be improved by using better breeding stock.

- Selective breeding to improve the quantity and quality of livestock and poultry production should be continued and broadened.

H. Farm Size and Tenure - Farm tenure and size of farms strongly influences the success of farming operations. More information is needed about farm size and tenure to guide land settlement programs.

- Studies should be conducted to determine the size of farm and production needed for a viable economic unit.

CHAPTER 6

PROJECTS FOR IMMEDIATE IMPLEMENTATION

Contents

CHAPTER 6

PROJECTS FOR IMMEDIATE IMPLEMENTATION

6.1 BACKGROUND

The urgent need for early identification of potential project areas for development as expressed by GOA Officials has been recognized in this study. However, the scope and short time frame of the study limited the number of potential project areas which could be identified.

At the present time, it is recognized that in the broad context there are water surplus and water short areas. With this in mind, a cursory review was made of the recommendations contained in the Agricultural Development Plan for the Upper Helmand Valley, dated March 1976, prepared for the Asian Development Bank by the International Engineering Company, Inc. As the Phase I study is the first look at the soil and water resources of the entire basin, the review was made in the context of what effect the proposed developments may have on the total basin development plan. Any comments made are, at best, only an opinion based on what is visualized by the study team members as a possible development plan for the basin.

6.2 ASIAN DEVELOPMENT BANK REPORT

The Asian Development Bank report presents several good proposals. The Seraj Project seems most promising and should be placed as first priority.

It will provide supplemental water to some land that is already irrigated and it will provide water to over 10,700 ha (26,500 ac) of relatively good soils not presently irrigated. 2/

The project also lies in an area of good transportation and social facilities. The Lower Darweshan Project should be given the next highest priority. The West Kajakai and Lower Shamalan Projects should probably be placed on a lower priority.

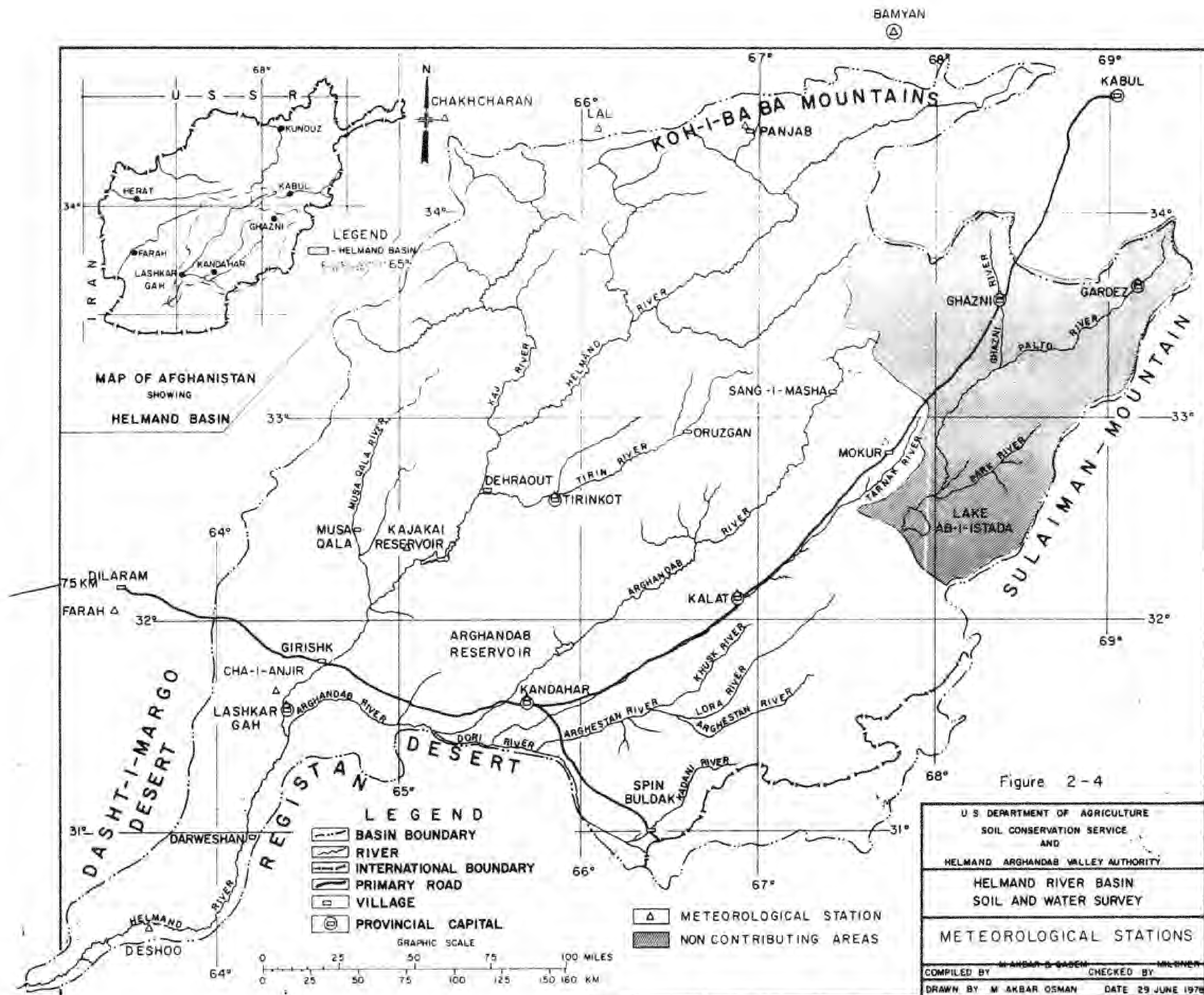
There may not be much conflict between these proposals and future long range development of the soil and water resources of the basin. This is particularly true since there is quite a bit of uncommitted water resource in the area, and since most of the proposals involve land that is in the number I and II priority for soil investigation as identified in the Phase I study.

It seems only logical to proceed with a detailed investigation of each of these proposals prior to commitment of large sums of money and technical manpower. More exact or precise information should be available for the final plans. Ordinarily, this means more detailed engineering data for structural design of diversions, drop structures, turnouts, siphons, drains, canals, and roads. But just as important is the need for detailed data on soils. The soils and their characteristics should be accurately determined in the proposed project and adjacent areas. This will allow the better soils to be developed for irrigation. It will allow more exact location of drains in accordance with

drainage characteristics, and it will allow villages to be located for best comfort, accessibility, and utility.

6.3 MARJA FOREST AREA

The study has revealed that the 2,430 ha (6,000 ac) forest area on the East Marja project has possibilities for the settlement of up to 400 families. It is further discussed in chapter five, paragraphs 5.3A, 5.4A and 5.5A of this report.



BAMYAN
KOH-I-BABA MOUNTAINS
CHAKHCHARAN
LAL
PANJAB
KABUL
GHAZNI
GARDEZ
GHAZNI RIVER
PALTO RIVER
SULAIMAN MOUNTAIN
SANG-I-MASHA
ORUZGAN
MOKUR
TARNAK RIVER
PARK RIVER
LAKE AB-I-ISTADA
HELMAND RIVER
KAJ RIVER
MUSA QALA RIVER
DEHRAOUT
TIRIN RIVER
TIRINKOT
MUSA QALA
KAJAKAI RESERVOIR
ARGHANDAB RIVER
KALAT
75 KM
DILARAM
FARAH
GIRISHK
ARGHANDAB RESERVOIR
CHA-I-ANJIR
KANDAHAR
KHUSK RIVER
LORA RIVER
ARGHESTAN RIVER
LASHKAR GAH
DORI RIVER
REGISTAN DESERT
DASHT-I-MARGO DESERT
SPIN BULDAK
KADANI RIVER
DARWESHAN
DESHOO
MAP OF AFGHANISTAN SHOWING HELMAND BASIN
U S S R
IRAN
KUNDUZ
HERAT
FARAH
LASHKAR GAH
KANDAHAR
LEGEND
HELMAND BASIN
LEGEND
BASIN BOUNDARY
RIVER
INTERNATIONAL BOUNDARY
PRIMARY ROAD
VILLAGE
PROVINCIAL CAPITAL
GRAPHIC SCALE
0 25 50 75 100 MILES
0 25 50 75 100 125 150 160 KM
METEOROLOGICAL STATION
NON CONTRIBUTING AREAS
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AND
HELMAND ARGHANDAB VALLEY AUTHORITY
HELMAND RIVER BASIN
SOIL AND WATER SURVEY
METEOROLOGICAL STATIONS
COMPILED BY M AKBAR & QASEM
CHECKED BY MILSNER
DRAWN BY M AKBAR OSMAN
DATE 29 JUNE 1978

Figure 2-4

CHAPTER 1

INTRODUCTION

1.1 PURPOSE

This study will help the Government of Afghanistan formulate sound technical plans for the systematic beneficial development of the total soil and water resources in the Helmand River Basin. The study identifies by first approximation, the quantity and quality of soil and water resources in the basin. It also indicates the present stage of development or utilization of these resources.

1.2 AUTHORITY

The services for this study were authorized by a Project Implementation Order for Technical Services, executed on September 9, 1975, between the Government of Afghanistan (GOA), and the United States Agency for International Development (USAID). It is known as the HAV (Helmand Arghandab Valley) Soil and Water Survey, Project/Activity Number 306-11-120-145.

1.3 SCOPE

The Scope of Work for Phase I is as follows:

- Collect existing reports and information from suitable sources.
- Review existing reports and other available information and analyse them for completeness, uniformity, conflicts, and

Table 2-2 Mean Monthly Temperature - Celsius [1,5]/*

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
Mountains Resources Area													
Chakhcharan	-10.4	-9.9	2.4	9.2	13.1	17.1	18.9	17.2	14.5	7.0	3.2	-3.7	6.6
1968-75	(13.3)	(14.2)	(36.3)	(48.6)	(55.6)	(62.8)	(66.0)	(63.0)	(58.1)	(44.6)	(37.8)	(25.3)	(43.9)
Gardez	-6.1	-7.0	2.7	10.5	15.6	21.1	21.9	20.0	16.6	9.7	4.4	-2.5	8.9
1971-75	(21.0)	(19.4)	(36.9)	(50.9)	(60.1)	(70.0)	(71.4)	(68.0)	(61.9)	(49.5)	(39.9)	(27.5)	(48.0)
Ghazni	-5.2	-3.6	4.5	10.7	15.5	20.8	22.9	22.2	17.3	10.6	4.6	-1.4	9.9
1959-75	(22.6)	(25.5)	(40.1)	(51.3)	(60.3)	(69.4)	(73.2)	(72.0)	(63.1)	(51.1)	(40.3)	(29.5)	(49.8)
Lal	-13.5	-10.7	-2.7	4.6	9.1	13.5	15.6	14.5	9.8	4.4	-1.0	-7.3	3.0
1965-75	(7.7)	(12.7)	(27.1)	(40.3)	(48.4)	(56.3)	(60.1)	(58.1)	(49.6)	(39.9)	(30.2)	(18.9)	(37.4)
Panjab	-14.4	-12.3	-3.0	5.2	10.6	15.4	17.4	16.5	11.8	5.8	-0.3	-8.4	3.7
1968-75	(6.0)	(9.9)	(26.6)	(41.4)	(51.1)	(59.7)	(63.3)	(61.7)	(53.2)	(42.4)	(31.5)	(16.9)	(38.7)
Desert Upland Resources Area													
Kandahar	6.6	9.3	14.2	19.6	24.4	27.6	29.7	27.9	23.3	17.6	11.9	7.7	18.3
1940-59	(43.9)	(48.7)	(57.6)	(67.2)	(75.9)	(81.6)	(85.5)	(82.3)	(73.9)	(63.7)	(53.5)	(45.9)	(65.0)
Kajakai	7.2	10.0	16.7	20.0	24.4	29.4	30.0	27.8	18.9	18.3	11.7	8.3	18.3
1956-60	(45.0)	(50.0)	(62.0)	(68.0)	(76.0)	(85.0)	(86.0)	(82.0)	(66.0)	(65.0)	(53.0)	(47.0)	(65.0)
Mokur	-5.5	-4.7	5.8	12.5	17.3	22.6	24.6	23.6	18.0	12.2	5.7	-0.8	11.0
1966-75	(22.1)	(23.5)	(42.4)	(54.5)	(63.1)	(72.7)	(76.3)	(74.5)	(64.4)	(54.0)	(42.3)	(30.6)	(51.8)
Kalat	-0.9	0.8	8.8	14.7	20.4	25.1	27.5	25.7	20.4	13.9	8.7	3.7	14.1
1967-75	(30.4)	(33.4)	(47.8)	(58.5)	(68.7)	(77.2)	(81.5)	(78.3)	(68.7)	(57.0)	(47.7)	(38.7)	(57.4)
Tirinkot	1.7	3.9	12.0	17.0	22.6	29.4	29.1	26.3	21.9	14.7	8.5	3.7	15.9
1972-75	(35.1)	(39.0)	(53.6)	(62.6)	(72.7)	(84.9)	(84.4)	(79.3)	(71.4)	(58.5)	(47.3)	(38.7)	(60.6)
Desert Plain Resource Area													
Chah-i-Anjir	8.0	10.8	14.9	24.4	28.5	32.0	33.3	30.0	25.2	16.5	12.0	9.1	20.4
1951-55	(46.4)	(51.4)	(58.8)	(75.9)	(83.3)	(89.6)	(91.9)	(86.0)	(77.4)	(61.7)	(53.6)	(48.4)	(68.7)
Deshoo	6.1	10.9	17.8	24.0	29.3	33.6	34.4	30.1	25.9	18.5	13.2	7.3	20.9
1972-75	(43.0)	(51.6)	(64.0)	(75.2)	(84.7)	(98.5)	(93.9)	(86.2)	(78.6)	(63.3)	(55.8)	(45.1)	(69.6)
Farah	7.2	10.2	15.5	21.3	26.6	31.8	33.6	31.2	26.3	20.6	13.2	8.6	20.5
1960-75	(45.0)	(50.4)	(59.9)	(70.3)	(79.9)	(89.2)	(92.5)	(88.2)	(79.3)	(69.1)	(55.7)	(47.5)	(68.9)
Lashkar Gah	7.8	10.6	16.7	20.6	26.7	31.1	32.8	30.6	25.6	19.4	12.8	5.0	19.4
1951-70	(46.0)	(51.0)	(62.0)	(69.0)	(80.0)	(88.0)	(91.0)	(87.0)	(78.0)	(67.0)	(55.0)	(41.0)	(67.0)

* Figures in parentheses are fahrenheit.

through April, with occasional showers in November and May. Influence of the Indian monsoom sometimes makes itself felt with minor precipitation during July. The Mountains Resource Area receives more of the July precipitation than does the Desert Upland or Desert Plain Resource Area.

Total precipitation for the basin occurs mainly as snow which rarely forms a permanent cover at elevations under 2,000 m (6,560 ft). In the higher parts of the basin, the snow cover lasts throughout the cold period and melts completely by mid-July. Table 2-3 shows mean monthly precipitation.

C. Evaporation - The climatic conditions cause rates of evaporation which greatly exceed precipitation. Table 2-4 gives data on mean monthly evaporation.

D. Growing Season - The period of record for the stations listed in Table 2-2 is not of the same duration nor is it known if it is for the same general period of time as those listed in Table 2-5. Therefore, the results show only a general trend. It can be noted that Kandahar in the Desert Upland Resource Area has a longer mean number of frost free days than does Lashkar Gah in the Desert Plain. This phenomenon is just the opposite of what might be expected since Kandahar has a colder average winter temperature than the stations in the Desert Plain

Table 2-3 Mean Monthly Precipitation in Millimeters 1,5/*

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Mountains Resource Area													
Chakhcharan	39.1	30.0	28.7	27.7	12.0	0.9	0	0	0	6.3	6.9	17.8	169.4
1968-75	(1.5)	(1.2)	(1.1)	(1.1)	(0.5)	(0.03)	0	0	0	(0.2)	(0.3)	(0.7)	(6.73)
Gardez	35.8	69.6	67.0	55.4	22.8	7.2	17.5	7.6	0.6	3.6	8.8	28.9	324.8
1964-75	(1.4)	(2.7)	(2.6)	(2.2)	(0.9)	(0.3)	(0.7)	(0.3)	(0.02)	(0.14)	(0.3)	(1.1)	(12.66)
Ghazni	44.0	55.0	62.6	50.7	21.2	2.7	14.4	1.0	0	0.9	9.9	28.4	290.8
1959-75	(1.7)	(2.2)	(2.5)	(2.0)	(0.8)	(0.1)	(0.6)	(0.04)	0	(0.04)	(0.4)	(1.1)	(11.48)
Lal	29.8	46.6	51.5	61.9	34.9	2.8	0	0	1.7	8.2	16.3	25.0	278.7
1965-75	(1.2)	(1.8)	(2.03)	(2.4)	(1.4)	(0.1)	0	0	(0.07)	(0.3)	(0.6)	(1.0)	(11.0)
Panjab	37.0	61.4	72.2	69.1	29.4	0.8	0.4	0	0	8.6	12.5	52.3	343.7
1968-75	(1.5)	(2.4)	(2.8)	(2.7)	(1.2)	(0.03)	(0.02)	0	0	(0.3)	(0.5)	(2.06)	(13.51)
Desert Upland Resource Area													
Kajakai	65.0	44.0	35.0	16.0	6.0	0	3.0	0	0	0	6.0	28.0	203.0
Est. 27 yr. ave.	(2.5)	(1.7)	(1.3)	(0.6)	(0.2)	0	(0.1)	0	0	0	(0.2)	(1.1)	(7.9)
Kandahar	50.8	35.8	37.1	23.4	7.6	0	2.3	0	0	0.3	4.3	20.3	181.9
1939-67	(2.0)	(1.41)	(1.46)	(0.92)	(0.3)	0	(0.09)	0	0	(0.01)	(0.17)	(0.8)	(7.16)
Mokur	40.8	52.8	42.0	20.6	7.0	0.1	1.2	1.5	0	2.0	7.7	37.6	213.3
1966-75	(1.6)	(2.08)	(1.6)	(0.8)	(0.2)	(T)	(0.05)	(0.06)	0	(0.08)	(0.3)	(1.5)	(8.27)
Kalat	50.9	69.7	51.2	21.7	1.6	0	3.4	2.2	0	0.9	6.9	50.2	258.7
1967-75	(2.0)	(2.7)	(2.0)	(0.8)	(0.06)	0	(0.1)	(0.09)	0	(0.04)	(0.3)	(2.0)	(10.2)
Tirinkot	45.0	46.2	24.6	26.2	4.7	0	6.2	0	0	0	3.5	57.6	214.0
1972-75	(1.8)	(1.8)	(1.0)	(1.0)	(0.2)	0	(0.2)	0	0	0	(0.1)	(2.3)	(8.4)
Desert Plain Resource Area													
Chah-i-Anjir	32.1	38.5	36.8	7.8	1.8	0	0	0	0	0	0.2	5.9	124.4
1951-55	(1.3)	(1.5)	(1.4)	(0.3)	(0.07)	0	0	0	0	0	(0.07)	(0.2)	(4.9)
Deshoo	21.5	7.7	31.3	1.9	1.5	0	0	0	0	0	0.8	8.3	73.0
1972-75	(0.8)	(0.3)	(1.2)	(0.07)	(0.06)	0	0	0	0	0	(0.03)	(0.3)	(2.9)
Farah	24.3	21.3	17.0	8.4	1.4	0	0	0	0	T	3.3	14.4	90.1
1960-75	(1.0)	(0.8)	(0.7)	(0.3)	(0.5)	0	0	0	0	T	(0.1)	(0.6)	(3.55)
Lashkar Gah	21.1	16.0	21.0	13.0	3.0	0	0	0	0	0	3.0	12.0	90.0
1951-70	(0.83)	(0.63)	(0.83)	(0.52)	(0.12)	0	0	0	0	0	(0.12)	(0.47)	(3.52)

* Figures in parentheses are in inches.

Table 2-4 Average Monthly Evaporation in Millimeters 1,5/*

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Mountains Resource Area													
Chakhcharan	11.0	10.0	42.0	83.0	132.0	196.0	203.0	219.0	155.0	96.0	44.0	20.0	1,211.0
1968-70	(0.4)	(0.4)	(1.7)	(3.3)	(5.2)	(7.7)	(8.0)	(8.6)	(6.1)	(3.7)	(1.7)	(0.8)	(47.6)
Ghazni	17.0	18.0	53.0	77.0	160.0	233.0	219.0	230.0	188.0	114.0	58.0	32.0	1,399.0
1959-70	(0.7)	(0.7)	(2.0)	(3.0)	(6.3)	(9.2)	(8.6)	(9.0)	(7.4)	(4.5)	(2.3)	(1.3)	(55.0)
Lal	5.0	7.0	18.0	38.0	77.0	121.0	141.0	151.0	115.0	63.0	31.0	15.0	782.0
1965-70	(0.2)	(0.3)	(0.7)	(1.5)	(3.0)	(4.8)	(5.6)	(5.9)	(4.5)	(2.5)	(1.2)	(0.6)	(30.8)
Panjab	6.0	9.0	27.0	46.0	100.0	165.0	193.0	197.0	153.0	80.0	40.0	15.0	1,031.0
1968-70	(0.2)	(0.3)	(1.1)	(1.8)	(3.9)	(6.5)	(7.6)	(7.8)	(6.0)	(3.1)	(1.6)	(0.6)	(40.5)
Desert Upland Resource Area													
Kajakai	61.0	82.0	114.0	190.0	270.0	351.0	381.0	318.0	235.0	214.0	130.0	70.0	2,391.0
1956-60	(2.4)	(3.2)	(4.5)	(7.5)	(10.6)	(13.8)	(15.0)	(12.5)	(9.2)	(8.4)	(5.1)	(2.7)	(94.1)
Kandahar	73.0	84.0	149.0	201.0	326.0	415.0	459.0	421.0	335.0	233.0	141.0	90.0	2,927.0
1951-59	(2.9)	(3.3)	(5.9)	(7.9)	(12.8)	(16.3)	(18.0)	(16.6)	(13.2)	(9.2)	(5.6)	(3.5)	(115.2)
Mokur	22.0	21.0	69.0	143.0	192.0	297.0	323.0	332.0	278.0	181.0	100.0	53.0	2,011.0
1966-70	(0.9)	(0.8)	(2.7)	(5.6)	(7.6)	(11.7)	(12.7)	(13.0)	(10.9)	(7.1)	(3.9)	(2.1)	(79.0)
Kalat	36.0	43.0	94.0	153.0	237.0	334.0	343.0	305.0	277.0	189.0	107.0	62.0	2,180.0
1967-70	(1.4)	(1.7)	(3.7)	(6.0)	(9.3)	(13.1)	(13.5)	(12.0)	(10.9)	(7.4)	(4.2)	(2.4)	(85.8)
Desert Plain Resource Area													
Chah-i-Anjir	60.0	88.0	138.0	242.0	338.0	474.0	432.0	386.0	286.0	214.0	149.0	71.0	2,994.0
1951-55	(2.4)	(3.4)	(5.4)	(9.5)	(13.3)	(18.6)	(17.0)	(15.1)	(11.2)	(8.4)	(5.9)	(2.9)	(117.9)
Farah	67.0	78.0	135.0	163.0	264.0	381.0	414.0	366.0	288.0	197.0	125.0	90.0	2,568.0
1960-70	(2.6)	(3.0)	(5.3)	(6.4)	(10.4)	(15.0)	(16.3)	(14.4)	(11.3)	(7.8)	(4.9)	(3.5)	(101.1)
Lashkar Gah	85.3	100.7	169.0	227.4	332.7	430.3	441.0	398.0	309.0	216.0	118.0	93.0	2,920.0
1955-70	(3.4)	(4.0)	(6.6)	(8.9)	(13.1)	(16.9)	(17.4)	(15.7)	(12.2)	(8.5)	(4.6)	(3.7)	(115.9)

* Figures in parentheses are in inches.

Resource Area. It could possibly be explained by the fact that the period of record was different. It also might be true, due to air drainage down the valley, or for some other reasons, which may give a micro climate change.

Table 2-5 Growing Season 1/

	Mean Date of First Killing Frost	Mean Date of Last Killing Frost	Mean Number of Frost Free Days
Mountain Resource Area			
Lal (6 Yrs. Record)	Aug. 27	June 7	80
Panjab (6 Yrs. Record)	Sep. 5	May 8	119
Ghazni (13 Yrs. Record)	Oct. 12	Apr. 6	188
Desert Upland Resource Area			
Kandahar (8 Yrs. Record)	Nov. 20	Feb. 21	271
Mokur (5 Yrs. Record)	Oct. 21	Apr. 10	195
Kalat (4 Yrs. Record)	Nov. 2	Mar. 28	218
Desert Plain Resource Area			
Farah (11 Yrs. Record)	Nov. 20	Feb. 22	270
Lashkar Gah (11 Yrs. Record)	Nov. 16	Feb. 19	269

2.4 VEGETATION

Very little published data is available on the flora of the Helmand River Basin, but limited reports and notes reveal a wide variety of plant life. 13/

These plants can be best described and classified on the basis of the three resource areas defined in this report.

A. Mountains Resource Area - Vegetation here is the most varied of all areas, because of favorable moisture conditions and cooler temperatures. However, countless years of timber cutting, uncontrolled grazing and wildfires have eliminated or altered the vegetation on all exposed sites, and the general appearance of the area is barren and scantly vegetated, except in early spring. Coniferous and decidous forest trees are the usual climax vegetation in areas such as this in most parts of the world, but in the Helmand River Basin, they have been nearly, if not completely eliminated.

Nevertheless, there are tall grasses, such as brome, wild ryes, fescues, stipas, and aristidas, growing on the protected mountain slopes and meadows. Shrubs growing along the streams and on the hillsides include hawthorn, rock rose, wild olive, barberry, and many others. Sycamore, poplar, ash, willow and other trees grow in the well watered sites.

B. Desert Upland Resource Area - Shrubs, such as artemisia, camel-thorn and astragulus, grow on the best soils. The taller, more palatable grasses that are usually found under these growing conditions have been almost totally eliminated by centuries of grazing by sheep and goats. However, more favorable rainfall and slightly cooler seasons than in

the lower deserts have aided in maintaining this area as fair grazing land in spite of heavy usage. Bulbous bluegrass and many vetches, clover and other legumes furnish grazing in the early spring. Poplar, ash and willow trees grow along the rivers and streams.

Occasional flowering and fruiting shrubs, such as wild almond, pistachio, wild prune, cotoneaster, and silver berry grow along the dry washes and on the outwash fans and low rocky foothills.

C. Desert Plain Resource Area - Vegetation on the terraces and benches above the river flood plain consists of low shrubs, short grasses and forbes. In early spring after a series of rains, these short grasses, flowering shrubs and other plants, including numerous low or creeping legumes, grow abundantly and the more favored areas may resemble miniature flower gardens or meadows. However, with the first high temperatures of summer, most of these plants become dormant.

Both the sandy flood plains and the stabilized river flood plain areas are covered by occasional clumps of tall grasses and tamerisk. Ash and willow trees, giant reed, and bamboo grasses grow on the river-banks. The deep alluvial soils that are either free of salts or only slightly saline are covered with small thorny shrubs and coarse grasses. The tall coarse grasses such as giant wild ryegrass provide some

grazing through late winter and early spring, but become too coarse to be palatable at full growth.

2.5 POPULATION

The Helmand River Basin, covering an area of 139,800 km^2 (53,975 mi^2) has a very uneven population distribution resulting from a variety of conditions. The majority of the population is concentrated in those parts of the basin where suitable conditions for agriculture exist. Very few people live in the largely waterless desert and the mountain areas.

Population figures by province were taken from existing studies[8/] and a percentage factor applied to them. The factor depended upon the proportion of the province within the basin and the judgment of the Afghan Counterparts on the study team on the percentage of the population thought to exist in the basin portion of the province.

Table 2-6 shows the estimated population within the total basin, and how the estimated figure of 2,000,000 is distributed.

Table 2-6 Population Estimates of the Helmand River Basin by Provinces

Province	Capital	Rural Pop. 8/	Est. % Rural Pop. in Basin	Calculated Rural Pop. in Basin	Urban Pop. in Basin 8/	Total
Bamyan	Bamyan	199,831	25	49,960	-	49,960
Ghazni	Ghazni	574,374	100	574,370	-	574,370
Ghor	Chakcharan	165,373	3	4,960	-	4,960
Helmand	Lashkar Gah	305,891	98	299,770	21,000	320,770
Kandahar	Kandahar	372,936	92	343,100	160,000	503,100
Maydan	Kotae Ashro	308,344	7	21,580	-	21,580
Oruzgan	Tirinkot	323,129	98	316,670	-	316,670
Paktya	Gardez	405,104	40	162,040	-	162,040
Zabul	Kalat	110,880	100	110,880	-	110,880
Total		2,7 65,862		1,883,330	181,000	2,064,330

2.6 ROADS AND COMMUNICATIONS

All or portions of the provinces of Helmand, Kandahar, Bamyan, Oruzgan, Paktya, Ghor, Maydan, Ghazni, and Zabul lie within the total basin. The province capitals, Lashkar Gah, Kandahar, Kalat, Ghazni, Gardez and Tirinkot, are also within the basin and are shown on Figure 2-2. Most province capitals are served by gravel roads, but Kandahar, Kalat and

Ghazni lie on the main paved circular highway linking these provinces with Kabul. Unsurfaced roads connect the main districts of the other provinces. They are suitable for motorized travel most of the year, except during the rainy season, and in the spring when torrent debris often blocks or destroys stretches of road. Farm to market roads are almost nonexistent.

As elsewhere in the country, in spite of the increasing use of trucks, much internal goods transport is still being done by pack animals. Telephone and telegraph communications are available between important provincial and national centers.

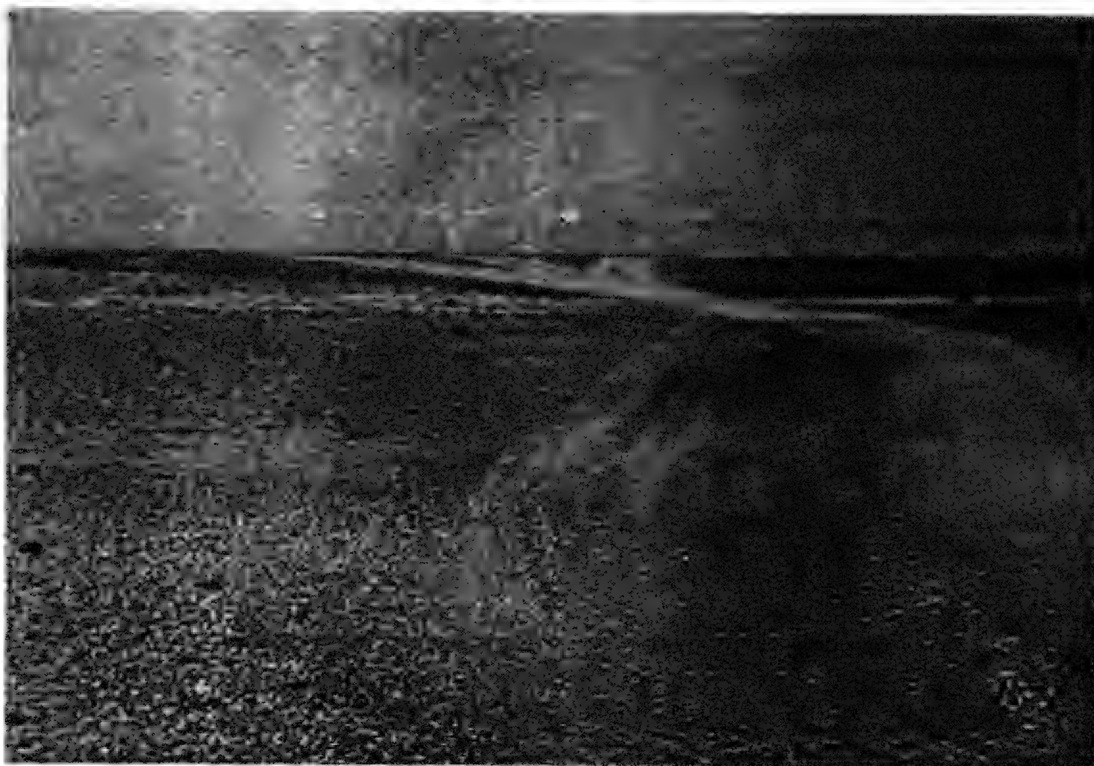


Figure 2-5 Unsurfaced Road

accuracy.

- Conduct several representative soil and water examinations to verify the land and water classifications used in previous reports and recommend a procedure to be used for standardization into a single system.

- Summarize the information contained in existing records and reports into a statement outlining what is known about the soil and water resources of the Helmand Arghandab Valley region.

- Review the Asian Development Bank (ADB) study and their findings and recommendations.

- Prepare a scope of work for Phase II including the priorities for work and the personnel and commodity requirements.

1.4 STUDY PROGRAM

USAID provided a five-man resident team of professionals from the Soil Conservation Service (SCS) of the United States Department of Agriculture (USDA) through a Participating Agency Service Arrangement (PASA), from May to August 1976. They consisted of a study leader, a geologist, a hydrologist, a soil scientist, and an agronomist/soil conservationist. GOA provided a ten-man counterpart team from the Helmand-Arghandab Valley Authority (HAVA), and the Water and Power Authority (WAPA) consisting of two geologists, two soil specialists, three engineers, two

2.7 REGIONAL GEOLOGY AND PHYSIOGRAPHY

The geology and physiography of the Mountains Resource Area is steep rugged mountains composed predominantly of limestone of the Permo-Triassic age and minor amounts of granitic materials of the Carboniferous and Precambrian age.[8a/] Volcanic and sedimentary rocks also occur. The mountains trend in a northeasterly-southwesterly direction in conformity with the regional geologic structure. The valleys are long and narrow. The geologic structure and stratigraphic sequence are not well known, but faulting is probably more important than folding in determining the structure of the area. Alluvium is usually limited in both depth and aerial extent, being found in valleys and alluvial fans located adjacent to the valleys. This alluvium usually contains ground water. The present rugged topography is probably the result of weathering in an arid climate.

The geology and physiography of the Desert Upland Resource Area is mostly Quaternary-Tertiary alluvium with isolated mountains and low hills which rise abruptly from the valley floor. The valley fill material forms either low gradient alluvial fans or river terraces. The upper terraces are usually underlain by a relatively impermeable conglomerate layer at less than 10 m (30 ft). Slopes range from less than one percent on the valley floor to nearly vertical in the isolated mountains. The valleys are probably structurally controlled rather than being erosional features. Under either condition, there is a good possibility that they

contain alluvium to a depth of 300 m (980 ft) or more. Ground water is usually present at shallow depths of less than 20 m (65 ft). Terrace deposits often overlie fine grained material.

The lower section of the bain or Desert Plains Resource Area is composed of various river terraces and other alluvial deposits of Qaternary-Tertiary age. The surface of these deposits is relatively flat and smooth with the steepest grades lying between terraces. Slopes are generally less than one percent, but can be as high as 25 percent between terraces. The upper terraces are usually underlain by a relatively impermeable conglomerate layer at less than 10 m (30 ft). The surfaces of the upper terraces may be covered by recent dune material. Terrace deposits often overlie fine grained materials. Ground water is usually present at shallow depths of less than 30 m (90 ft).



Figure 2-6 Recent Dune Cover on Terraces near Marja Project

CHAPTER 3

SOIL RESOURCES

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CHAPTER 3

SOIL RESOURCES

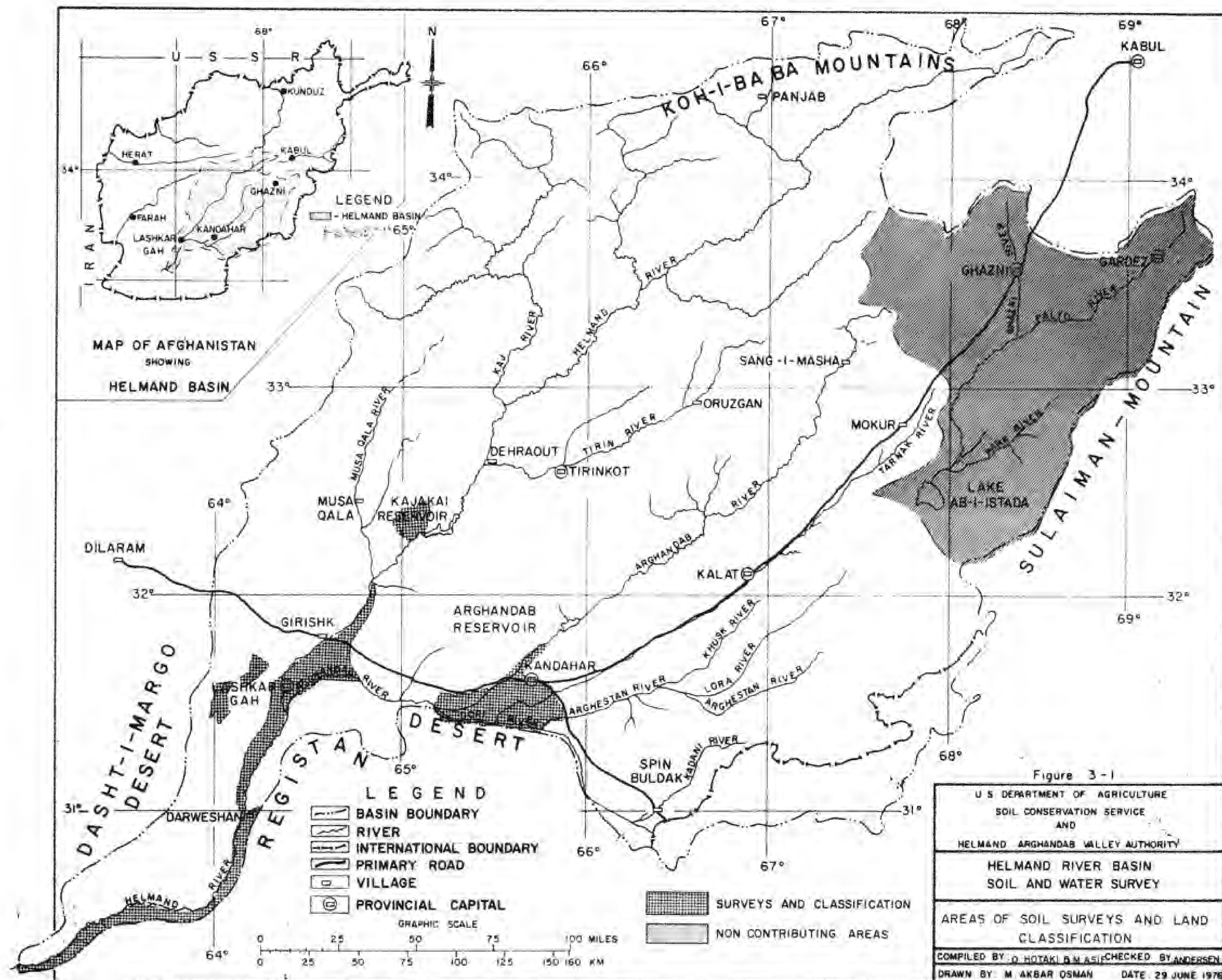
3.1 GENERAL

The soil is one of the major basic resources in the development of the Helmand River Basin. Selection of the most suitable soils for irrigation is crucial to successful long-term development. Making use of the most suitable soils will maximize production and minimize problems.

3.2 AVAILABLE DATA

Data available for broad planning of the Helmand River Basin soil resources are generally inadequate. The data which are available and fairly detailed encompass less than two percent of the basin. The data are limited to studies of 3,031 km^2 (1,170 mi^2) in the southern half of the basin as shown on Figure 3-1. No single publication contains all the known soil resource data for the basin. The published data and various records are retained in the offices of the Helmand Arghandab Valley Authority (HAVA) in Lashkar Gah.

The bulk of the available data is in the form of one soil survey, two irrigated land classifications, and several studies of soils properties.[13,28,29/] It was gathered during the periods of 1952 to 1958, and 1965 to 1969. The Land Development Planning Division of HAVA collected some additional soils data from areas, both inside and outside of the projects. The bulk of



MAP OF AFGHANISTAN
SHOWING
HELMAND BASIN
U — S — S — R
IRAN
KUNDUZ
HERAT
KABUL
GHAZNI
FARAH
LASHKAR GAH
KANDAHAR
LEGEND
- HELMAND BASIN
N
KOH-I-BABA MOUNTAINS
PANJAB
KABUL
GHAZNI
GARDEZ
SULAIMAN — MOUNTAIN
SANG-I-MASHA
ORUZGAN
MOKUR
TARNAK RIVER
LAKE AB-I-ISTADA
HELMAND RIVER
KAJ RIVER
MUSA QALA RIVER
TIRIN RIVER
DEHRAOUT
TIRINKOT
MUSA QALA
KAJAKAI RESERVOIR
DILARAM
ARGHANDAB RIVER
KALAT
GIRISHK
ARGHANDAB RESERVOIR
KANDAHAR
KHUSK RIVER
LORA RIVER
ARGHESTAN RIVER
LASHKAR GAH
DASHT-I-MARGO DESERT
REGISTAN DESERT
SPIN BULDAK
KADANI RIVER
DARWESHAN
HELMAND RIVER
LEGEND
BASIN BOUNDARY
RIVER
INTERNATIONAL BOUNDARY
PRIMARY ROAD
VILLAGE
PROVINCIAL CAPITAL
GRAPHIC SCALE
0 25 50 75 100 MILES
0 25 50 75 100 125 150 160 KM
SURVEYS AND CLASSIFICATION
NON CONTRIBUTING AREAS
64° 65° 66° 67° 68° 69°
31° 32° 33° 34°
Figure 3-1
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AND
HELMAND ARGHANDAB VALLEY AUTHORITY
HELMAND RIVER BASIN
SOIL AND WATER SURVEY
AREAS OF SOIL SURVEYS AND LAND CLASSIFICATION
COMPILED BY: O HOTAKI & M ASIF CHECKED BY: ANDERSEN
DRAWN BY: M AKBAR OSMAN DATE: 29 JUNE 1976

material gathered by HAVA since 1969 is not published, and in many instances is not readily available or useable because it is not organized or plotted on maps. However, the West Marja area report prepared in 1972 [12a] does contain some of the HAVA data, including a land classification map.

Maps prepared during the course of the soil surveys, land classifications, and special soils studies, which are still available, are listed in Table 3-1. The special studies are described in the three basic references. [13,28,29] The maps and reports are on file in the HAVA offices.

The special soils studies included the following:

- o Permeability
- o Infiltration
- o Water holding capacity
- o Hydraulic conductivity
- o Depth to ground water table
- o Slope of ground water table
- o Thickness of shallow aquifers
- o Depth to and slope of the drainage barrier
- o Salinity
- o Boron concentrations
- o Alkalinity

The data for soil surveys, land classification, and special studies were

Table 3-1 Soil and Related Date Maps Available in HAVA File 1976

Source [a]	Drawing No.	Title of Map	Date	Scale	No. of Sheets
Seraj					
MKA	LD 56	Detail Soil Survey	Feb. 1955	1:20,000	9
MKA	LD 119	Seraj Photo Key Map	Feb. 5/57	1:20,000	9
MKA	LD 120	Seraj Irrigation Development Land Groups	Feb. 23/57	1:20,000	9
MKA	LD 152	Location of Pits & Logs	May 1958	1:40,000	1
MKA	LD 153	Potential Land Capability	May 1958	1:40,000	1
MKA	LD 154	Present Land Capability	June 1958	1:40,000	1
MKA	LD 156	Depth to Aquifer	July 1958	1:40,000	1
MKA	LD 157	Drainability Map	July 1957	1:40,000	1
Shamalan					
MKA	LD 26	Detail Soil Survey	May 1954	1:20,000	7
MKA	LD 162	Potential Land Capability with Soil Deficiencies	Nov. 1958	1:20,000	7
USBR	LC 501-5/133	Detail Land Classification	1967	1:5,000	129
USBR	501-123-127	Detail Land Classification	Mar. to Apr. 1967	1:40,000	5
USBR	501-151-155	Drainage Investigations	June 1967	1:40,000	5
USBR	501-138-142	Depth to Water Table Contours Multiple Profile	April 1967	1:40,000	5
USBR	501-143	Drainage Investigations	July 1967	hor/1:20,000 vert/1:400	1
USBR	501-144-150	Obs.Well Hydrographs	July 1967	hor/1:200	7
Darweshan					
MKA	LD 73	Detail Soil Survey	Sept. 1955	1:20,000	9
MKA	LD 126	Photo Key Map	July 1957	1:20,000	9
MKA	LD	Present Land Capability	May 1958	1:20,000	9
MKA	LD 155	Potential Land Capability	June 1958	1:20,000	9
Nad-i-Ali					
MKA	LD 96	Photo Index	Feb. 1956	1:20,000	1
MKA	LD 98 a&b	Detail Soil Survey Including Salinity Survey	Sept. 1956	1:8,000	8
MKA	LD 98c	Pits and Sample Log	May 1956	1:8,000	8
MKA	73-147	Ground Water Contours	Oct. 1953	1:20,000	1
MKA	73-201	Drainage Survey	Sept. 1956 to June 1957	1:20,000	1
MKA	73-203	Drainability	Sept. 1957	1:20,000	1
MKA	73-205	Drainage Pit Locations	Sept. 1957	1:20,000	1
East Marja					
MKA	90-18	Land Classification	Sept. 1953	1:33,333	1
MKA	90-53	Conglomerate Topography	Apr. 1954	1:33,333	1
ACU	704-186	Recon. Land Classification	Oct. 1963	1:20,000	1
ACU	704-189 R1	Recon. Land Classification	Nov. 1963	1:33,333	1
ACU	704-190	Depth to Drainage Barrier	Nov. 1963	1:33,333	1
ACU	704-191	Permeability & Drainage Layout	Nov. 1963	1:33,333	1
ACU	704-192	Drainability Map	Nov. 1963	1:33,333	1
West Marja					
HAVA	Unnumbered	Land Classification Map	Dec. 1971	1:50,000	1
Garmsell					
MKA	LD 137	Recon. Soil Survey	March to May 1955	1:20,000	11
North Arghandab					
MKA	LD 22	Recon. Soil Survey	Nov. 1953	1:20,000	6
MKA	LD 158	Present Land Capability	Aug. 1958	1:20,000	6
MKA	LD 159	Potential Land Capability	Aug. 1958	1:20,000	6
Central Arghandab					
MKA	LD 92	Detail Soil Survey	Jan. 1956	1:20,000	10
MKA	LD 160	Present Land Capability	Sept. 1958	1:20,000	10
MKA	LD 161	Potential Land Capability	Oct. 1958	1:20,000	10
Tarnak					
MKA	LD 88	Detail Soil Survey	Nov. 1955	1:20,000	10
MKA	LD 108	Photo Key Map	July 1956	1:20,000	10
MKA	LD 141	Potential Land Classes	Aug. 1957	1:40,000	1
MKA	LD 142	Development Areas and Land Classes	Sept. 1957	1:40,000	1
MKA	LD 150	Present Land Capability	Apr. 1956	1:40,000	1
MKA	LD 169	Depth to Ground Water	Mar. 1958	1:40,000	1
MKA	LD 170	Ground Water Contours	Feb. 1958	1:40,000	1
MKA	LD 171	Present and Recent Irrigation Patterns	Nov. 1957	1:40,000	1
MKA	100-187	Hydraulic Conductivity 0.00-0.5	June 1957	1:40,000	1
MKA	100-188	Hydraulic Conductivity 1.00-4.00	June 1957	1:40,000	1
MKA	100-194	Topo., Pits and Non-reclaimable Lands	June 1957	1:20,000	6
ACU	705-110	Test Pit Location and Elevation	Oct. 1961	1:8,000	1

a/ MKA Morrison-Knudsen Afghanistan
USBR United States Bureau of Reclamation
ACU Afghan Construction Unit
HAVA Helmand Arghandab Valley Authority

adequate for the limited purpose for which they were intended. The procedures and techniques used were the best available at the time the work was done.

3.3 GENERAL DESCRIPTION OF THE SOIL RESOURCE

Brief general descriptions and the classification of the broad groups of soils are given in this section. Figure 3-2 is a schematic soil classification map. The soil classification made in this chapter is based on the taxonomic system presently used by the Soil Conservation Service (SCS), United States Department of Agriculture (USDA) [29a/]

A. Rock Outcrop - This is mostly bare exposed limestone bedrock. Extrusive and intrusive rocks also outcrop on mountains in the basin. Rock outcrop is not considered to be soil.

B. Soils on Mountains - These soils are mostly less than 0.46 m (1.5 ft) deep, coarse textured, very gravelly, cobbly, or stony, and well drained. The size ranges of gravel, gobbels, and stones are shown in Table 3-2. These soils generally have rapid permeability. Slopes range from about 35 percent to nearly vertical. The soils occur in cracks, crevices, and drainage ways of otherwise continuous rock outcrop. They are classified mostly as Cryorthents at the upper elevations and Torriorthents at the lower elevations.

C. Soils on Alluvial Fans - These soils are mostly more than 0.46 m

agronomists, and an agricultural economist.

Field observations, report analyses, and report preparation were conducted by the 15 man Study Team. All of the data and the analyses made by the team were assembled by the study leader and his counterpart from August to November 1976. The report was printed by USAID in Afghanistan.

1.5 AREA OF STUDY

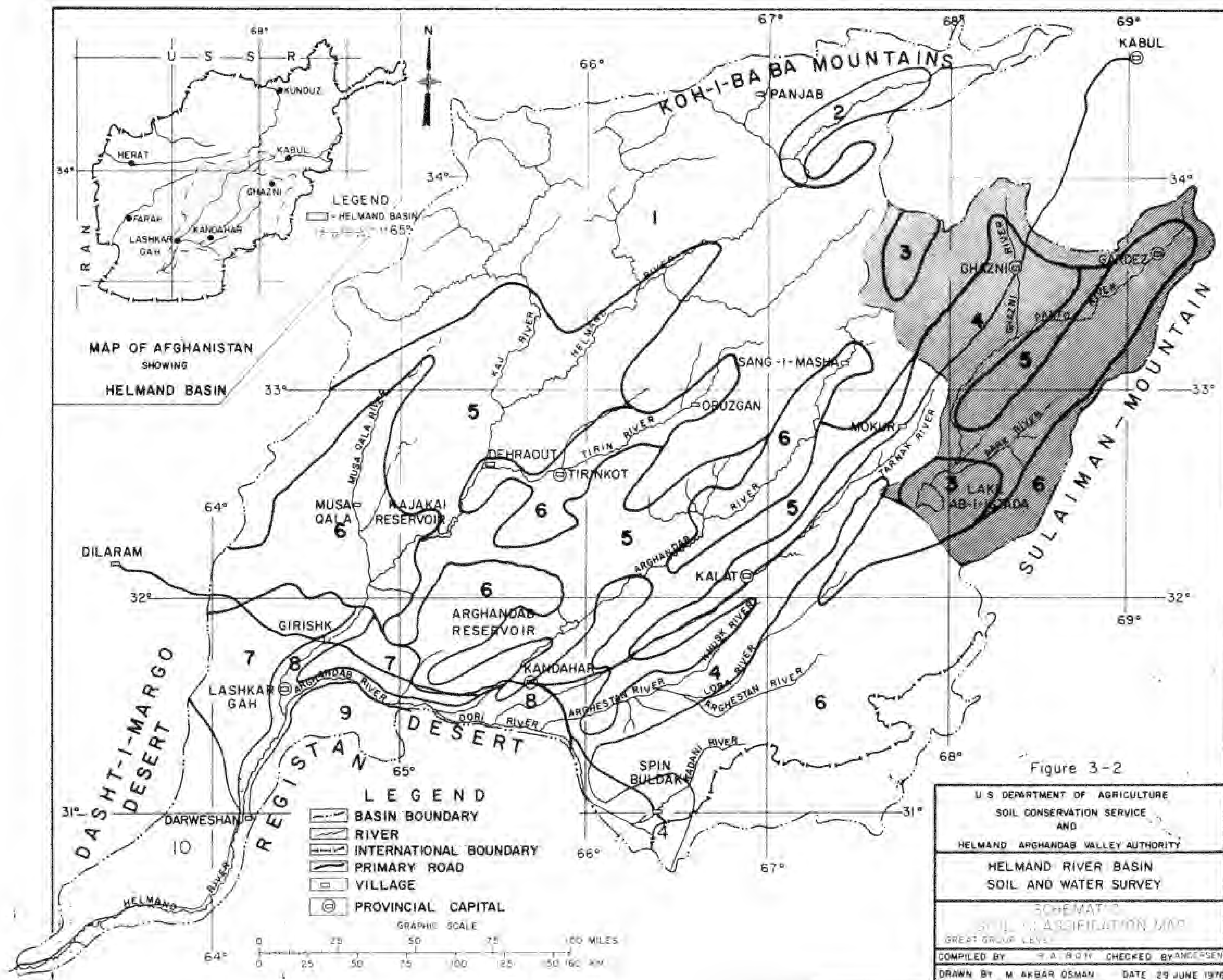
The area of this study is defined as the Helmand River and all its tributaries above the Helmand provincial boundary below Deshoo. The definition is an interpretation of two other definitions which have been used. The Project Paper, dated February 12, 1975, defines it as the "Arghandab, Tarnak, and Helmand River systems down to below Deshu" and the letter requesting assistance with the survey to USAID, from the Republic of Afghanistan, dated February 5, 1975, defines it as "the Upper Helmand, Arghandab, and Tarnak River Basin, including their draining areas on the high plateau, which serve as a source of the water for these rivers down to Deshu."

The area studied has been called the Helmand River Basin or the basin throughout this report. It is further described in Chapter 2.

1.6 SUMMARY

A. Conclusions

- There is more potentially irrigable land available than



MAP OF AFGHANISTAN
SHOWING
HELMAND BASIN
U S S R
IRAN
KUNDUZ
HERAT
KABUL
GHAZNI
FARAH
LASHKAR GAH
KANDAHAR
LEGEND
HELMAND BASIN
KOH-I-BABA MOUNTAINS
PANJAB
SANG-I-MASHA
ORUZGAN
MOKUR
DEHRAOUT
TIRINKOT
MUSA QALA
KAJAKAI RESERVOIR
DILARAM
GIRISHK
ARGHANDAB RESERVOIR
KANDAHAR
KALAT
LASHKAR GAH
SPIN BULDAK
DARWESHAN
GHAZNI
GARDEZ
LAKE AB-I-ISTADA
SULAIMAN – MOUNTAIN
DASHT-I-MARGO DESERT
REGISTAN DESERT
HELMAND RIVER
KAJ RIVER
MUSA QALA RIVER
TIRIN RIVER
ARGHANDAB RIVER
TARNAK RIVER
GHAZNI RIVER
PAKTO RIVER
KUSHK RIVER
LORA RIVER
ARGHESTAN RIVER
DORI RIVER
KADANI RIVER
LEGEND
BASIN BOUNDARY
RIVER
INTERNATIONAL BOUNDARY
PRIMARY ROAD
VILLAGE
PROVINCIAL CAPITAL
GRAPHIC SCALE
0 25 50 75 100 MILES
0 25 50 75 100 125 150 160 KM
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AND
HELMAND ARGHANDAB VALLEY AUTHORITY
HELMAND RIVER BASIN
SOIL AND WATER SURVEY
COMPILED BY
CHECKED BY ANDERSEN
DRAWN BY M AKBAR OSMAN
DATE 29 JUNE 1976

Figure 3-2

(1.5 ft) deep, moderately coarse textured to moderately fine textured, and well drained or moderately well drained. They generally have moderate permeability to very slow permeability. Poorly drained soils occur in seepage zones toward the base of mountains. Slopes generally range from one to forty-five percent. Usually, the soils are gravelly, cobbly, or stony and frequently underlain by conglomerate or gravel cemented by silica. Washes are extremely gravelly or cobbly. The soils are classified mostly as Torriorthents. Salorthids also occur in closed basins in the non-contributing portion of the basin.

D. Soils on Upper River Terraces and Plains - These soils are mostly 0.23 m (0.75 ft) to 0.9 m (3.0 ft) deep, moderately fine textured, and well drained or moderately well drained. They generally have slow permeability. Slopes range from less than one percent on the flat portions of the area to as much as 30 percent on the dissected portions and between terraces. Frequently, the soils are very gravelly. Some soils have a thick lime layer which varies in hardness from place-to-place. Layers of gypsum also occur. Thick layers of conglomerate commonly are at depths ranging from one to five meters (3.3 to 16.4 ft) below the ground surface. Sand dunes occupy some areas. Washes are extremely gravelly or cobbly. The soils are classified mostly as Camborthids, Calciorthids, Gypsiorthids, and

Torripsamments.

E. Soils on Flood Plains and Lower Terraces - These soils are mostly more than 0.46 m (1.5 ft) deep, medium textured, and well drained or moderately well drained. They generally have moderate permeability. Coarser textured and shallow soils occur in the Mountains Resource Area. Slope generally are less than one percent. Usually, the soils are underlain by gravel. Washes are extremely gravelly or cobbly. The soils are classified mostly as Torrifluvents.

Table 3-2

Coarse Fragment Size Ranges

Gravel	Cobbles	Stones
2 mm - 76 mm	76 mm - 254 mm	More than 254 mm
(.79 in - 3 in)	(3 in - 10 in)	(More than 10 in)

The schematic soil classification map is shown in Figure 3-2. The units on the map are great soil groups or associations of great soil groups.

Each broad group of soils occurs in at least two resource areas Table 3-3 shows the percent of each broad group of soils in each resource area.

Table 3-3

Estimated Percentage of Broad Groups of Soils by Resource Area, Helmand River Basin

Broad Groups of Soils	Resource Area: Mountains	Resource Area: Desert Upland	Resource Area: Desert Plain	Weighted Basin Total
Rock Outcrop	35	15	-	21
Soils on Mountains	20	10	-	13
Soils on Alluvial Fans	40	60	35	50
Soils on Upper River Terraces and Plains	-	10	60	11
Soils on Flood Plains and Lower Terraces	5	5	5	5
Weighted Basin Total	40	50	10	100

3.4 SOIL CHARACTERISTICS

Soils have many chemical and physical properties which can be measured and used to characterize them. The significance of describing and studying combinations or sets of soil properties and explanation of several important properties studied previously in the basin are described in this section. Some of the effects each property has on irrigated and non-irrigated land used for agriculture are also discussed.

The behavior of a soil, when put to a specific use, is determined by the interaction of several physical and chemical properties. The interactions

many times are more significant factors in explaining soil behavior than individual soil properties. Therefore it is necessary to describe and study complete sets or combinations of soil chemical and physical properties instead of single soil properties.

Individual soils seldom if ever have identical sets of properties, but many have sets which are very similar to one another. Soils which do have very similar sets of properties can be grouped to make a soil unit.

The information and knowledge gained in one place about the behavior of each group of very similar soils or soil unit may be transferred directly to other places where the same soil unit is identified.

The following soil characteristics were studied separately in much detail within the project areas of the Helmand River Basin, but not in sets of characteristics or soil units. Therefore, the meaning and usefulness of the data gathered is limited. The significance of a particular soil characteristic may not be clear, unless other characteristics are associated or correlated with it.

A. Effective Soil Depth - This is the depth to which plant roots can penetrate to obtain moisture and nutrients from the soil. Effective soil depth can be limited by layers of bedrock, conglomerate, very compact soil, loose gypsum, and petrocalcic horizons or caliche. An abrupt change in soil texture or the presence of a water table

Can also limit effective soil depth. Deep soils are generally better for agricultural use than shallow soils of similar material.

Irrigated soils should be deep, to provide space for a drainage system which usually is an essential part of any irrigation system in the Desert Upland and Desert Plain Resource Areas and to provide ample storage for moisture and plant nutrients. Shallow soils may hold enough moisture and nutrients for crop growth but, when underlain by bedrock, conglomerate, or very compact soil layers, drains need to be installed too close together to be practical.

Non-irrigated soils should be deep enough to hold, within the root zone, the moisture which falls in the form of rain or snow.

B. Available Moisture Holding Capacity - This is the difference between the percent of moisture held in the soil two or three days after a soaking rain or irrigation and the percent in the soil when plants wilt and remain wilted at night. Available moisture holding capacity is affected by soil texture, percent of sand or gravel, and soil depth. Medium textured deep soils without gravel have the most available moisture holding capacity. Coarse textured, shallow, and very gravelly soils have very low capacities.

The available moisture holding capacity of irrigated soils should be high within the root zone. The frequency of irrigation can be less

for soils that have a high rather than low available moisture holding capacity. Low capacity soils require many small frequent irrigations.

The available mositure holding capacity of non-irrigated soils should be high enough within the root zone to hold the moisture which the soils receive in the form of rain or snow.

C. Infiltration Rate - This is a measure of the ease with which water can enter or penetrate the surface of the soil. Infiltration rate is affected by vegetative cover, soil texture, and organic matter content. Vegetative cover is important because it protects the soil from the force of the falling rain drops and by so doing helps prevent puddling and sealing of surface soil. Coarse textured soils usually have rapid infiltration rates and fine textured soils have slow rates. Soils with a high organic matter content tend to have stronger and more granular structure than soils with a low content. Low levels of organic matter encourage the breakdown of soil structure and crusting of the soil surface which reduces the infiltration rate.

The infiltration rate of irrigated soils should be rapid enough to avoid prolonged ponding of water on the surface of the soils. Ponding of water for a long period will kill or injure most crops.

Ideally, the infiltration rate of non-irrigated soils should be sufficient to prevent the loss of water by runoff. Runoff causes water erosion

and reduces the supply of water which can soak into the soil and become available for plant growth.

D. Drainability - This is the ease with which free water can be removed by gravity from the root zone of the soil. Soil texture, density, structure, and depth to a layer which restricts movement of free water, such as conglomerate, are factors that greatly influence drainability. Medium textured, loose, granular, and deep soils drain more easily than fine textured, compacted, and structureless more massive soils.

The drainability of irrigated soils should be good enough to avoid water logging which limits aeration of the soils and usually results in the accumulation of salts on the surface of the soil.

The drainability of non-irrigated arid soils in relation to the amount of moisture received is also important.

E. Salinity - This refers to the presence of certain salts in the soil. Salinity becomes a problem, when the salts are dissolved in the soil moisture in great enough concentrations to restrict the movement of moisture from the soil into the plant. Low salinity soils are good agricultural soils, if other properties are favorable. High salinity soils are poor agricultural soils and, if usable, require

more water, better quality water, and more intense drainage than do low salinity soils.

The salinity level of irrigated soils can be reduced relatively quickly by leaching the salts, provided the infiltration rate and drainability of the soils are good enough to avoid water logging. The salt content of the irrigation water must be less than that of the soils in order to leach successfully.

The change of salinity levels of non-irrigated soils is not considered significant.

F. Alkalinity - This refers to the presence of exchangeable sodium in the soil. The condition becomes a problem when the sodium is in great enough concentration and high enough proportion relative to the exchangeable calcium and magnesium concentration to destroy the soil structure and reduce the soil drainability. Low alkalinity soils are good for agricultural uses, if other properties are favorable. High alkalinity soils are poor soils for agricultural use. They need applications of gypsum, more and better quality of irrigation water, and more intense drainage systems than do similar low alkalinity soils.

The alkalinity levels of irrigated soils can be reduced relatively quickly by leaching the sodium salts if the infiltration rate and drainability of the soils are adequate and are maintained during the leaching process.

Gypsum usually should be applied prior to leaching to help maintain or improve the drainability of the soils.

The change of alkalinity levels of non-irrigated soils is not considered significant.

G. Topography - This describes the shape and slope of the soil surface. Soils which are level and smooth generally require less shaping and grading for distribution of irrigation water by gravity methods than soils which are steep and undulating.

The topography of soils determines in large measure the kind of water distribution system which can be used, and how much land leveling must be done before irrigating.

The topography of irrigated and non-irrigated soils influence where erosion and deposition will take place, where dry or wet areas will appear, where saline and alkaline areas may occur, and where difficulty may be encountered in getting over the land with equipment or animals.

H. Fertility - This refers to the natural ability of the soils to supply nutrients to plants. Soil organic matter content, texture, mineralogy, and acidity or alkalinity are factors which affect soil fertility. Soils which are high in organic matter content, moderately fine textured,

water with which to irrigate it.

- Little is known about the ground water resources.

- Not enough basic data are available to study water regimes accurately.

- The largest factor affecting irrigation efficiency is on farm use and between farm distribution of water.

B. Recommendations

- That a broad reconnaissance soil survey be initiated to identify the most suitable soils for future irrigation development.

- That studies be made on how to achieve equitable distribution of irrigation water to establish a basis for setting priorities on water use.

- That an inventory of ground water quantity and quality be made to locate and determine the amount of usable water available.

- That the systems for gathering stream flow, snow pack and meteorological data be strengthened and expanded as needed with a view to developing a capability for forecasting.

- That programs for increasing on farm irrigation efficiency be strengthened to obtain the best results with the water applied.

reasonably high in expanding type clays, and slightly acid in reaction, generally, are more fertile than soils which are low in organic matter, coarse textured, low in clay, and either strongly acid or strongly alkaline in reaction. Hot, arid soils usually are very low in organic matter content and are medium or strongly alkaline.

The fertility of irrigated soils can be maintained or improved by growing soil improving crops, adding organic matter, and applying commercial fertilizer.

The fertility of non-irrigated soils is important and should be maintained so that plants can utilize the moisture available.

3.5 CLASSIFICATION SYSTEM

Soils have many different chemical and physical characteristics or properties which interact and affect the way soils behave when used for any purpose. Eight soil characteristics are described in the preceding Section. There are many more recognized properties. Soil classification considers all the recognized properties.

There are so many different combinations of chemical and physical characteristics of soil that the mind cannot deal with them all simultaneously, without a system which organizes and categorizes them in a logical way. Several different recognized systems of soil classification have been developed in the world. To be most useful, a system should have the following features:

- Recognize quantitative rather than just qualitative criteria.
- Have several different categories or levels of generalization.
- Recognize real soils rather than just theoretical concepts of soils.
- Rely on soil properties which can be observed in the field or inferred from other observable features.
- Be capable of modification to accomodate new knowledge with a minimum of disturbance to the system.
- Be based on soil properties which normal cultural practices, such as plowing, do not change.
- Provide a place in the system for all soils no matter where they occur in the landscape or world.

The system of soil taxonomy used by the SCS [29a/] is an example of a basic method of soil classification for making and interpreting soil surveys. It is a recognized system and used in several countries throughout the world.

The multicategoric aspects of this kind of a soil classification system provides a way to subdivide and further define units as more specific soils information becomes available.

Land classification is one kind of soil interpretation. It is quite different from soil classification. Land classification considers only a few selected soil properties which are important for a specific land use, such as growing crops on irrigated land, and ignores or conceals other soil characteristics

and their interactions. Many of the interactions may be significant to the use and management of the soil for other purposes. Soils classified at the lowest, or most detailed category or phase of a category of a recognized classification system can be placed directly in many different single purpose land classification systems, such as the systems used by the International Engineering Company, Inc. (IECO) and the United States Bureau of Reclamation (USBR). The reverse is not true. Land classes are combinations of soil units, which respond similarly when used for the same single purpose. The land classification systems set up by IECO and USBR were basically designed to group soils according to their general suitability for irrigated agriculture.[13,28,29/]

The soil survey made by IECO, but not published, was based on an irrigated land classification system rather than a soil classification system. Numbers or letters were assigned to the soil properties of major significance in irrigated land classification. Effective rooting depth, surface soil texture, permeability of two subsurface layers, and nature of the underlying material were the major properties examined and coded. Additional properties included the slope, erosion, salinity, alkalinity, wetness, and flooding. The codes, however, were not correlated into a soil classification system with adequately defined and adequately described soil units. Instead, they were grouped into land classes.

3.6 USABILITY OF AVAILABLE DATA

The IECO survey is very difficult to use in predicting drain spacing, drainage feasibility, or boron levels. Drain spacing is very difficult to predict from the present data because the texture and alkalinity are not correlated with various drainability measurements. Zones of seepage along the canals and degrees of drainage feasibility are very difficult to predict for several of the same reasons. Boron levels are not correlated with other soil characteristics.

Much of the data collected over the past 20 years or more should be more useful after a detailed soil survey based on a soil classification system has been made and published. This is because the apparent variability in much of the single factor data will probably be explained in large part by the difference at the lowest level classification, soil series and their phases. The remaining unexplained variability may point out inconsistencies in the data.

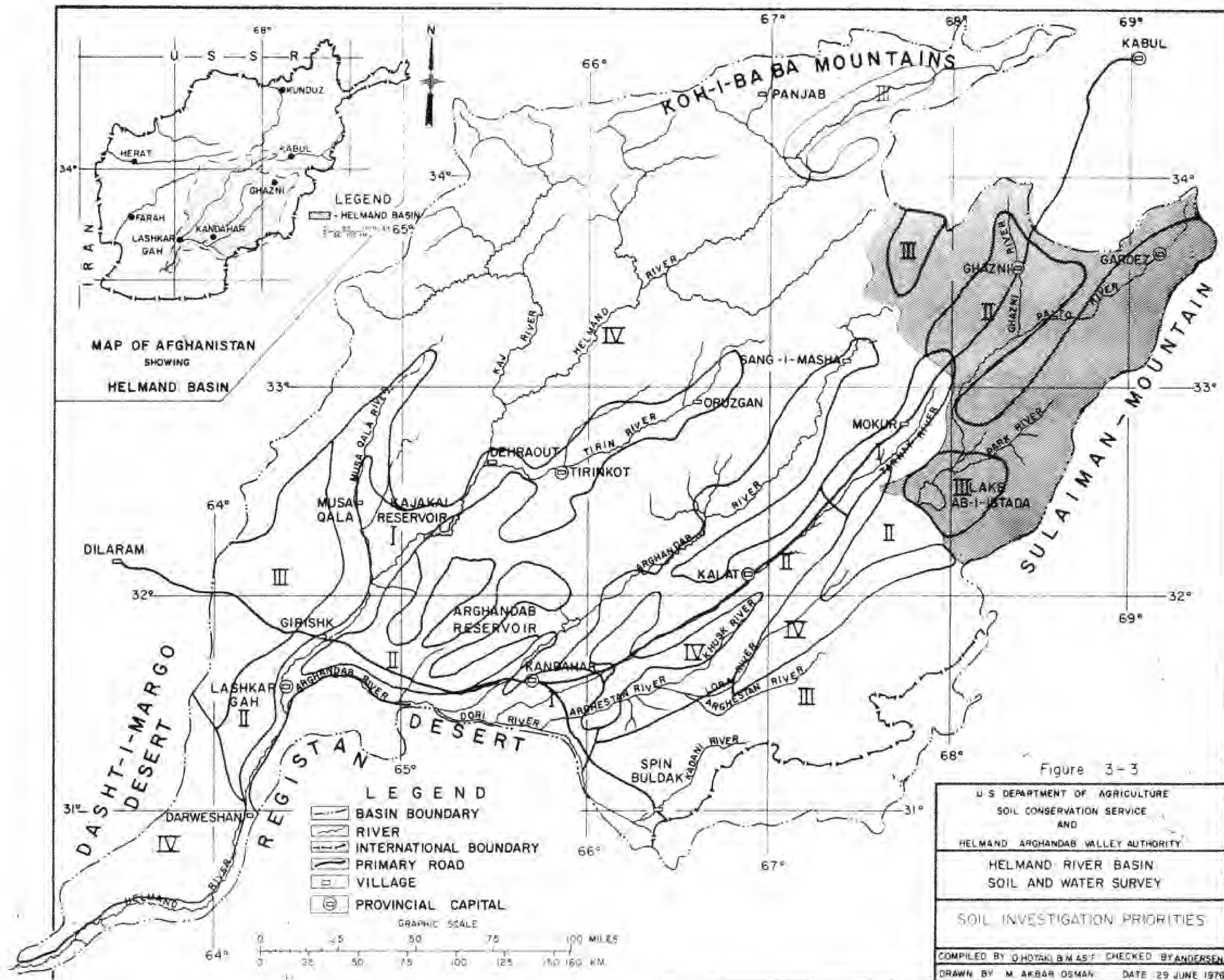
A soil survey based on a recognized soil classification system allows transfer of knowledge and experience gained in the use of the soils inside the project areas directly to the same kinds of soils outside. The amount of testing needed on soils mapped outside the present project areas could be reduced, because so much is already known about some of the same soils inside. New or different soils identified outside the project area will need to be studied closely.

Changes in salinity levels of each soil could be identified and trends established. This information could be used to improve drain spacing criteria and evaluate reclamation work.

3.7 PRIORITY SELECTION

An overall view of the soils in the basin is an essential tool needed for broad planning.

The soils information which can provide this view can be gathered in various degrees of detail as needed for different levels of planning. A recognized comprehensive soil classification system, which has several different categories or levels of generalization, should be used for the mapping of soils. Various maps should be prepared at several different levels of generalization. The view needed for broad basin planning should be very general, yet, detailed enough to locate areas in which suitable soils for development are expected to occur. Figure 3-3 is an interpretive map for that purpose based on the schematic soil classification map which was prepared at one of the higher levels of generalization, great soil group level. Both the soil classification map and interpretive map were compiled from the best information available. The information was in the form of previously prepared soils reports covering only a small portion of the basin, knowledge and experience of the counterparts acquainted with the soil in some other areas of the basin, study of topographic maps and aerial photographs, and extremely limited field checking done during this study.



MAP OF AFGHANISTAN
SHOWING
HELMAND BASIN
U S S R
IRAN
KUNDUZ
HERAT
KABUL
GHAZNI
FARAH
LASHKAR GAH
KANDAHAR
LEGEND
HELMAND BASIN
KOH-I-BABA MOUNTAINS
PANJAB
SULAIMAN - MOUNTAIN
GARDEZ
PALTO RIVER
GHAZNI RIVER
SANG-I-MASHA
ORUZGAN
MOKUR
TARNAK RIVER
PARK RIVER
LAKE AB-I-ISTADA
HELMAND RIVER
KAJ RIVER
TIRIN RIVER
DEHRAOUT
TIRINKOT
MUSA QALA RIVER
MUSA QALA
KAJAKAI RESERVOIR
DILARAM
GIRISHK
ARGHANDAB RESERVOIR
ARGHANDAB RIVER
KALAT
KHUSK RIVER
LORA RIVER
ARGHESTAN RIVER
KANDAHAR
DORI RIVER
KADANI RIVER
SPIN BULDAK
LASHKAR GAH
DARWESHAN
DASHT-I-MARGO DESERT
REGISTAN DESERT
L E G E N D
BASIN BOUNDARY
RIVER
INTERNATIONAL BOUNDARY
PRIMARY ROAD
VILLAGE
PROVINCIAL CAPITAL
GRAPHIC SCALE
0 25 50 75 100 MILES
0 25 50 75 100 125 150 160 KM
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AND
HELMAND ARGHANDAB VALLEY AUTHORITY
HELMAND RIVER BASIN
SOIL AND WATER SURVEY
SOIL INVESTIGATION PRIORITIES
COMPILED BY O HOTAKI, B M ASIF CHECKED BY ANDERSEN
DRAWN BY M. AKBAR OSMAN DATE 29 JUNE 1976

Figure 3-3

The areas of most potential, as designated on the interpretive map, should be investigated more closely to delineate the areas of most suitable soils for future irrigation development. Several weeks may be needed in each of these areas to make a reconnaissance soil survey. The information gathered at this intermediate level of generalization should be adequate for medium intensity planning and prefeasibility studies.

The intermediate level reconnaissance soil survey should be interpreted and areas of the most suitable soils designated for detailed mapping, if the decision is made to proceed with feasibility studies.

Several months or a few years may be needed in each area to make a detailed soil survey, depending on the size of the area, complexity of the soils patterns, and ease of traveling within the area.

3.8 CONCLUSIONS AND RECOMMENDATIONS

Adequate soils information is not available for basin-wide resource planning. A large quantity of relatively detailed soils information was gathered for a very small part of the basin. No multilevel soil classification system was used to make the initial soil survey. The soil survey provided only enough information for irrigated land classification. The land classification systems used by IECO and USBR differ somewhat in criteria and criteria limits. The information developed as a result of the special studies was not adequately correlated with the soil survey information to satisfy present needs.

A reconnaissance soil survey should be made of areas according to established priorities. The soil survey should be made within the framework of a recognized soil classification system which has several different categories or levels of generalization. Areas of highest development potential identified during the reconnaissance soil survey should be delineated and assigned priorities for further classification at a lower or more detailed level. Land capability, drainage, canal seepage, and other guides should be prepared as the need for them is identified.

The reconnaissance soil survey would provide adequate soils information for the entire basin by the time the last priority area is mapped. This information would help the hydrologists, engineers, planners, agriculturists, and farmers. Additional interpretation for related resources could be prepared from the soil survey as needed.

CHAPTER 4

WATER RESOURCES

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1.7 PRESENTATION

It will be helpful for the reader to understand the concepts used in the preparation of this report, as well as the way it is organized for presentation.

Although the Helmand River Basin is addressed as a single hydrologic unit, it is recognized that it is made up of many major and minor hydrologic units or watersheds. These watersheds have natural boundaries which subdivide the basin along hydrologic lines. The individual watersheds are discussed, as appropriate, in line with their importance to the total soil and water resources of the basin.

Another natural division which crosses watershed boundaries has been identified and delineated. These divisions have been called Resource Areas, as shown in Figure 2-3. They combine areas which have similar hydrology, geology, climate, cropping systems, and soils. The names of the Resource Areas have been used throughout the report to locate zones within watersheds and the basin as a whole for discussion purposes.

A portion of the basin is considered as non-contributing as shown in Figure 2-1. Unless otherwise specified, the discussion deals only with the contributing portion.

The report is published in two parts. Part I of the report, Chapters one through six, contains statements on what is known about the resources of

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CHAPTER 4

WATER RESOURCES

4.1 GENERAL

This chapter on water resources presents briefly the availability of data, water supply, water use, existing water resource facilities, potential water resource development, and conclusions and recommendations. Included are discussions on both the quantity and quality of the water resource.

Water is the limiting resource and is probably the most important single resource affecting the development of the Helmand River Basin. Presently, water is available to meet the needs of irrigation in the Helmand River watershed all of the time and is available in the Arghandab River watershed about 95 percent of the time. Water is available for expansion of the irrigated area even though there have been some local shortages.

It is important to understand the hydrologic cycle or relationship between water supply and use. The annual on-site consumptive use, consisting of transpiration by vegetation and evaporation from soil and snow surface, is relatively constant and does not respond immediately to precipitation. Figure 4-1 illustrates the hydrologic cycle for the Helmand River Basin.

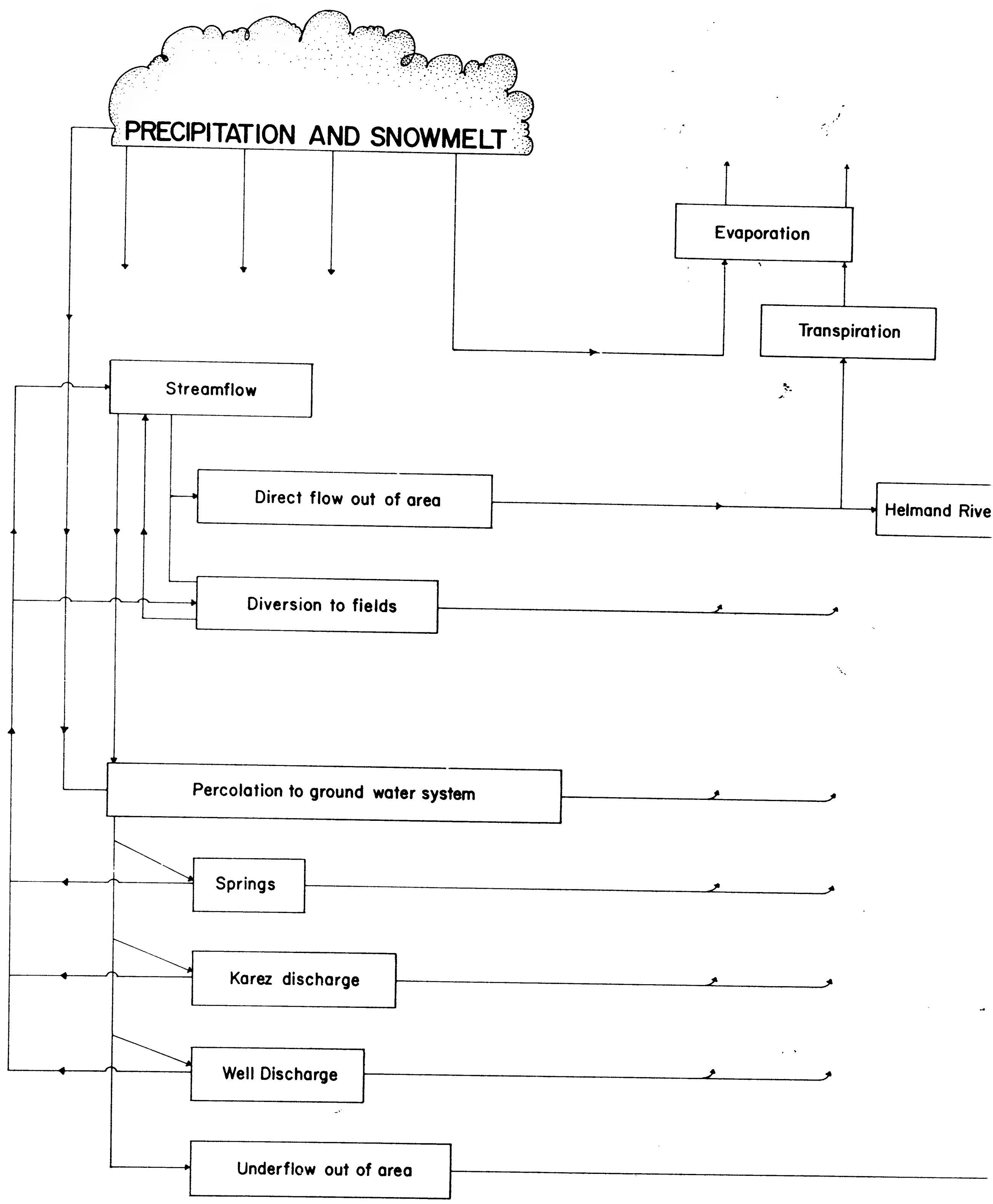


FIGURE 4-1 Hydrologic Cycle in the Helmand River Basin

4.2 AVAILABLE DATA

Data on water resources in the Helmand River Basin are generally scanty and inadequate. Various records have been kept and in some cases much information has been compiled and published. No central source or single publication was found that contained all desirable data on hydrology and water resources.

A. Meteorological - Since about 1957, some meteorological records of precipitation, air temperature, humidity, wind, atmospheric pressure, sunshine, evaporation, and soil temperature have been maintained. Some of this data has been published [1, 5, 27] and other uncompiled data is available only as it was obtained from the field.

B. Snow Pack - Several snow pack measurement stations have previously been established in the higher elevations of the Helmand River drainage. [5] Records and data are not available locally. Published information was not available.

C. Stream Gaging - Some stream gaging stations were established on the Helmand and Arghandab Rivers as early as 1946. Additional stations were established after the Kajakai and Arghandab Reservoirs were completed in 1952 and 1953. Other stations were added by the Government of Afghanistan (GOA) with the help of the United States Geological Survey (USGS) during the period 1966 through 1969. [31]

In 1968, 32 stream gaging stations were in operation within the Helmand River Basin.[7/] For the 1975 water year, only eight stations had records which were compiled and readily available. An additional 10 stations had some measurements but records were either incomplete, not computed, or unavailable. Stream gaging stations that have been established in the Helmand River Basin are listed in Table 4-1 and their locations shown on Figure 4-2. Availability of stream flow records for these stations is summarized in Table 4-2.

D. Reservoirs - Hydrologic data for Kajakai and Arghandab Reservoirs for the past 29 years are available at Helmand-Arghandab Valley Authority (HAVA). Data includes reservoir content, inflow, and release amounts from the reservoirs.

E. Ground Water - Little is known concerning the ground water resources of the Helmand River Basin. This is because not a great deal of data has been collected, the data is not always easily obtainable, no one organization has been the sole collector, and a complete inventory does not exist. Report on the Zamindawar and Kandahar areas covering shallow ground water are the most complete investigations.[19,26/] Some of the project areas have information on shallow ground water developed in conjunction with a series of drainage investigations.[23,28/] Information on deep ground water and quality of ground water are even more limited.

Table 4-1 Established Gaging Stations, Helmand River Basin [7,32]

USGS Station Number	Name and Location	Lat. N.	Long. E	Drainage area (Km²)	Alt. msl (m)	Type of Gage	Measuring Structure
7000.05	Helmand River near Gardendiwal	34° 30'	68° 12'			R	
7000.10	Helmand River near Ghizab	33° 25'	66° 20'		2,000	R	
7000.20	Helmand River near Dehraout	32° 41'	65° 30'	35,480	1,100	R	C
7000.28	Kajakai Reservoir near Kajakai	32° 19'	65° 07'	42,200	968	R	
7000.30	Helmand River below Kajakai Dam	32° 19'	65° 06'	42,200	960	RT	C
7000.36	Helmand River near Girishk	31° 48'	64° 35'	52,580	816	R	
7000.40	Helmand River at Lashkar Gah	31° 33'	64° 19'	57,760	764	S	B
7000.50	Helmand River at Darweshan	31° 01'	64° 05'	131,300	700	RT	C
7000.60	Helmand River at Malakhan	30° 27'	63° 23'			R	C
7500.20	Tirin River at Oruzgan	33° 00'	66° 40'			R	C
7500.30	Tirin River near Tirinkot	32° 40'	65° 59'			R	
7500.80	Tirin River at Nar Joi	32° 38'	65° 35'			R	C
7500.90	Tirin River near Dehraout	32° 40'	65° 30'	5,590	1,100	R	
7200.90	Markhana River near Panjab	34° 12'	66° 54'			R	C
7300.90	Panjab River near Panjab	34° 20'	66° 59'			R	
7400.90	Kaj River at Kshi near Kajiron	32° 57'	65° 32'			R	
7600.90	Musa Qala River at Musa Qala	32° 20'	64° 46'	3,750	970	R	
7700.90	Sangin Wash at Sangin	32° 04'	64° 52'			R	B
7800.20	Arghandab River near Sang-i-Masha	33° 17'	66° 10'			R	C
7800.30	Arghandab River at Maisan	32° 27'	66° 42'			R	C
7800.50	Arghandab River above Arghandab Res.	32° 01'	66° 10'	16,950	1,113	R	C
7800.58	Arghandab Res. near Kandahar	31° 51'	65° 54'	17,600	1,065	R	
7800.60	Arghandab River below Argh. Dam	31° 51'	65° 51'	17,800	1,050	RT	C
7800.70	Arghandab River near Kandahar	31° 37'	65° 35'			R	B
7800.90	Arghandab River near Qala-i-Bost	31° 33'	64° 19'	65,800	764	R	C
7820.90	Shah Joi Wash at Arghandab Reservoir	31° 53'	65° 54'			R	C
7880.20	Dori River near Spin Baldak	31° 22'	65° 53'			R	C
7887.30	Lora River Shinkai	31° 33'	66° 42'			R	C
7887.90	Arghestan River near Kandahar	31° 26'	65° 54'	17,150	1,018	R	B
7888.10	Tarnak River near Shah Joi	32° 32'	67° 27'			R	C
7888.90	Tarnak River near Kandahar	31° 37'	66° 00'			R	C
7889.90	Kushk-i-Nakhud at Kush-i-Nakhud	31° 39'	65° 04'			R	B

B - Bridge C - Cableway R - Recording Gage S - Staff Gage T - Thermograph

Table 4-2 Availability of Streamflow Records for Established Gaging Stations
Helmand River Basin - October 1947 to July 1976

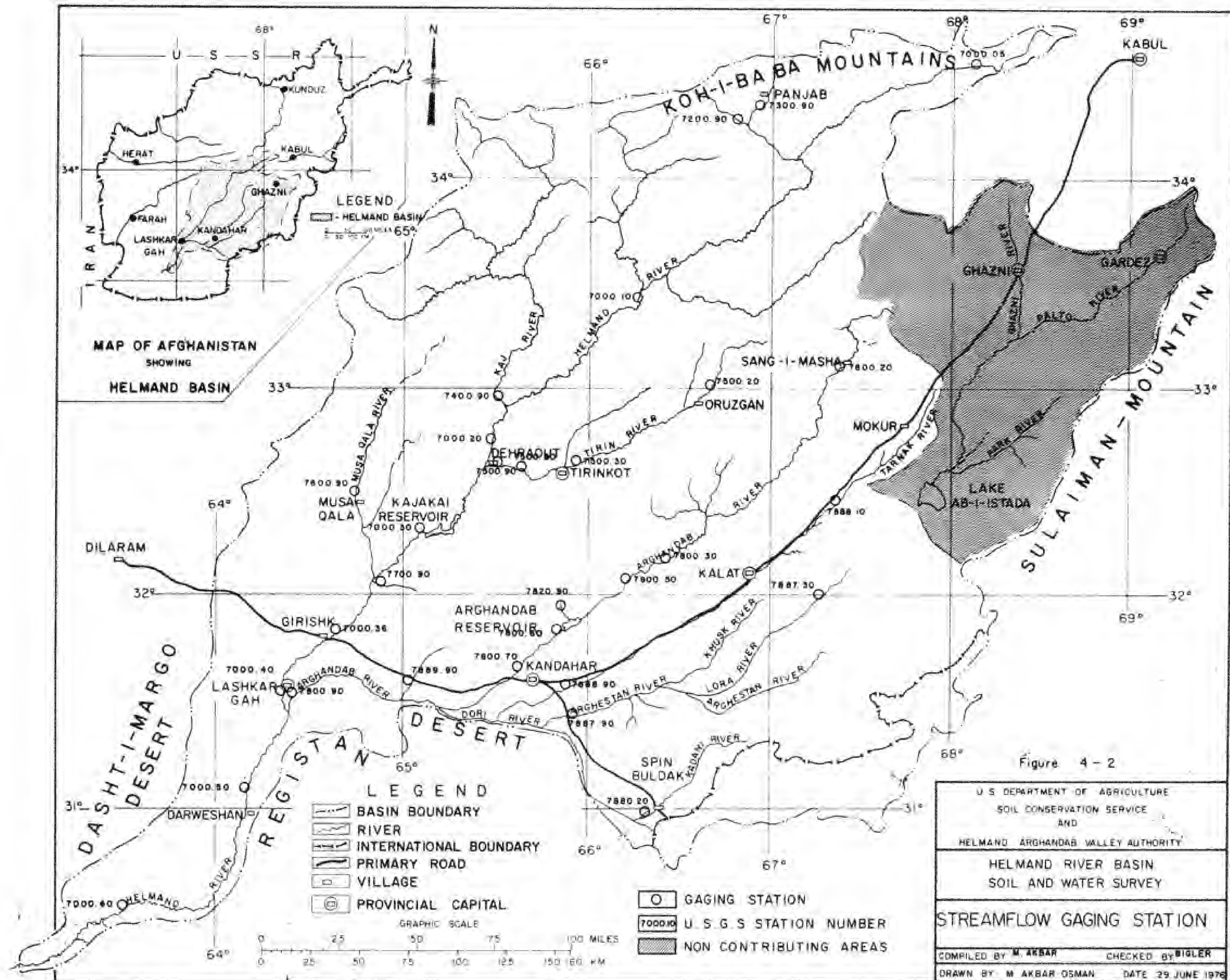
USGS Station Number	River	Water Year																												
		1947-48	1948-49	1949-50	1950-51	1951-52	1952-53	1953-54	1954-55	1955-56	1956-57	1957-58	1958-59	1959-60	1960-61	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76
7000.05	Helmand																						M	M	M	M	M	M	M	M
7000.10	Helmand																						M	M	I	I	I	I	I	U
7000.20	Helmand	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P
7000.28	Kajakai Res.						I	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P
7000.30	Helmand	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P
7000.36	Helmand																						M	M	M	M	M	M	M	M
7000.40	Helmand							A	A	A	M	M	M	M	M	M	M	M	M	M	M	M	N	N	N	N	I	I	N	U
7000.50	Helmand				A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	I	I	I	I	I	I	P
7000.60	Helmand																						M	I	I	I	I	I	I	P
7500.20	Tirin																						M	M	M	M	M	M	M	M
7500.30	Tirin																						M	I	I	A	A	I	U	U
7500.80	Tirin														I	A	A	A	I	A	I	A	I	I	A	I	A	A	A	P
7500.90	Tirin						A	A	A	A	A	A	A	A	A	A	A	A	A	A	I	I	M	M	M	M	M	M	M	M
7200.90	Markhana																						M	M	M	M	M	M	M	M
7300.90	Panjab																						M	M	M	M	M	M	M	M
7400.90	Kaj																						M	M	R	R	R	R	R	R
7600.90	Musa Qala						A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	I	I	I	I	I	N	N	N	N
7700.90	Sangin Wash																						M	M	M	M	M	M	M	M
7800.20	Arghandab																						M	A	A	A	A	A	A	P
7800.30	Arghandab																						M	M	M	M	R	R	R	R
7800.50	Arghandab					A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P
7800.58	Arghandab Res.					A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P
7800.60	Arghandab	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P
7800.70	Arghandab																						M	I	A	A	A	A	N	N
7800.90	Arghandab	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	I	N	N	N
7820.90	Shah Joi Wash																						M	M	M	M	M	M	M	M
7880.20	Dori																						R	M	M	M	M	M	M	R
7887.30	Lora																						R	M	R	M	M	M	M	R
7887.90	Arghestan						A	M	A	A	A	A	M	M	A	A	A	A	A	A	M	A	M	M	M	M	M	M	M	M
7888.10	Tarnak																						M	M	M	M	M	M	M	M
7889.90	Kushk-i-Nakhud																						M	M	M	M	M	M	M	M
7888.90	Tarnak																						M	M	M	M	M	R	R	R

A-Available - records are complete and available
M-Missing - records are missing, not taken or lost
U-Unavailable - records are unavailable, measurements were made
P-Partly available - records are available to date, not complete for entire year

I-Incomplete - records are incomplete for some months but are available
N-Not computed - computations are not completed, measurements have been made
R-Random - random and incomplete measurements were made

the basin. It also contains an analysis of the information with conclusions and recommendations on soils, water resources, and land use and management. It is published as a final report. Numbers in tables may not always check exactly, because of rounding off for clarity and conversion from one measuring system to another.

Future planning for development of the basin is discussed, and the proposed Phase II Project is outlined in Part II of the report. Part II, consisting of Chapters seven, eight, and nine is published separately as a draft report.



MAP OF AFGHANISTAN
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HELMAND BASIN
KOH-I-BABA MOUNTAINS
SULAIMAN-MOUNTAIN
PANJAB
SANG-I-MASHA
ORUZGAN
MOKUR
GHAZNI
GARDEZ
LAKE AB-I-ISTADA
DEHRAOUT
TIRINKOT
MUSA QALA
KAJAKAI RESERVOIR
DILARAM
GIRISHK
ARGHANDAB RESERVOIR
KANDAHAR
KALAT
LASHKAR GAH
SPIN BULDAK
DARWESHAN
DASHT-I-MARGO DESERT
REGISTAN DESERT
HELMAND RIVER
KAJ RIVER
MUSA QALA RIVER
TIRIN RIVER
ARGHANDAB RIVER
TARNAK RIVER
GHAZNI RIVER
PALTO RIVER
ARGHESTAN RIVER
KHUSK RIVER
LORA RIVER
DORI RIVER
KADANI RIVER
LEGEND
BASIN BOUNDARY
RIVER
INTERNATIONAL BOUNDARY
PRIMARY ROAD
VILLAGE
PROVINCIAL CAPITAL
GRAPHIC SCALE
0 25 50 75 100 MILES
0 25 50 75 100 125 150 160 KM
GAGING STATION
U.S.G.S STATION NUMBER
NON CONTRIBUTING AREAS
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AND
HELMAND ARGHANDAB VALLEY AUTHORITY
HELMAND RIVER BASIN
SOIL AND WATER SURVEY
STREAMFLOW GAGING STATION
COMPILED BY M. AKBAR
CHECKED BY BIGLER
DRAWN BY M. AKBAR OSMAN
DATE 29 JUNE 1976

Figure 4 - 2

F. Sedimentation - Sedimentation data is confined to reports on a survey of Kajakai and Arghandab Reservoirs [24, 25] and some obscure references in other reports on sediment problems [6]. The Kajakai and Arghandab reports are quite detailed and factual but the other reports are only general in nature.

G. Flooding - Data on flood flows and flood damages are very minimal. Fairly good data have been collected on some streams for peak flows but data for washes and streams are almost non-existant. Some historical flood flows have been reconstructed using high water marks and information from local people. Several reports contain some data and analyses on flood flows and peak discharges but no single study has addressed itself to an overall flood damage investigation.

4.3 EXISTING FACILITIES

A brief discussion of the existing facilities that are used to transport, store, and regulate the water resources is important in order to have a better understanding of the inter-relationship of water supply, water use, and potential development of the water resources in the Helmand River Basin.

A. Irrigation Systems - The present irrigation network operated and maintained by HAVA is 755 km (482 mi). This includes the

Boghra Canal and its branches, the Darweshan Canal, the Seraj Canal, and the South Canal and the Tarnak branches. There are also 3,443 km (2,140 mi) of main roads and project roads operated and maintained by HAVA in connection with the irrigation and drainage projects.[11]

1. Boghra Canal and Branches - The Boghra Canal headworks is located at the Boghra Diversion Dam on the Helmand River 64 km (40 mi) northeast of Lashkar Gah. It extends 75 km (47 mi) in a southwesterly direction and furnishes water to the Marja, Nad-i-Ali, and Shamalan areas as well as providing water to several non-project areas along the way. The Boghra Canal has a capacity of 72.3 m^3/s (2,550 cfs) from the diversion to the Shamalan Canal Branch. A wasteway and checkgate structure is located at station 10+917 about 5 km (3.1 mi) downstream from the Girishk powerplant.[9] About 15 km (8 mi) of the Boghra Canal is lined.

The Shamalan Canal branches off the Boghra Canal at station 31+680 about 16 km (10 mi) north of Lashkar Gah and extends south a distance of 66 km (41 mi) and is generally parallel to the Helmand River.[9] The capacity of the canal gradually decreases from its maximum of 21.2 m^3/s (750 cfs) to 2.1 m^3/s (75 cfs) at its lower end. Turnouts are provided throughout the length of the canal.

Turnouts on the Boghra Canal provide water to the Nad-i-Ali area. Main turnouts are located at stations 40, 41, 43 and 44 with other smaller turnouts down to station 56+500. From station 56+500 to station 69 on the Boghra Canal, turnouts are located to provide irrigation water to a non-project area which was originally intended for a forest area but has been settled and used for irrigated cropland. Another branch of the Boghra Canal begins at station 70. This branch provides water to about half of the Marja area and is about 12 km (7.5 mi) long.

The original capacity of the Boghra Canal at station 70 before lining in 1962 was 16.1 m^3/s (569 cfs). After lining the canal between station 70 and 75, the capacity was reduced to 7.5 m^3/s (264 cfs) [10/] because of reduction of cross sectional area.

2. Darweshan Canal - The Darweshan Diversion is located on the Helmand River approximately 58 km (36 mi) south of Lashkar Gah. The canal has a capacity of 28.3 m^3/s (1,000 cfs) and extends south about 50 km (31 mi) parallel to the Helmand River. The steel piling used for bank protection on the left bank of the river downstream from the Darweshan Diversion settled and has required significant maintenance. The spring flood in 1976 damaged the right bank both above and below the

steel piling which is used for cutoff control. Maintenance must be done promptly on damaged areas such as these to prevent more costly repairs in the future.

3. Other Canals diverting from the Helmand River - From the Kajakai Dam to Deshoo, there are an estimated 23 diversions to the left and 10 to the right on the Helmand River in addition to the Boghra and Darweshan Diversions. These are all farmer built and maintained in the traditional style of brush and gravel.



Figure 4-3 Brush and Gravel Diversion in the Helmand River

Perhaps the largest of these is the Seraj Canal which diverts just above the Sangin Wash and serves land as far south as Lashkar Gah and the Arghandab River. The Seraj Canal starts on the left bank of the Helmand River about 50 km (31 mi) below Kajakai. The

original capacity was 22.7 m^3/s (800 cfs). Lack of maintenance reduced the capacity to about 5.7 m^3/s (200 cfs) but HAVA has restored it to about 10.5 m^3/s (370 cfs). The water that leaves the river bottom area and is used to irrigate the desert land is about 4.5 m^3/s (160 cfs). 6/

The number of canals and diversions from the Helmand River above Kajakai Reservoir is not known. In the Dehraout and Tirin areas several diversions have been observed. Others occur in the high elevations of the Helmand River and its tributaries.

4. Other Canals diverting from Tributaries - Little information was found which gave the number and length of canals which divert water from other rivers and streams in the Helmand River Basin. Many farmer built canals divert water from various rivers including the Musa Qala, Tarnak, Arghestan, Dori and Lora Rivers.

5. Arghandab South Canal - The Arghandab South Canal diversion is located on the Arghandab River about 20 km (12.4 mi) north of Kandahar. This canal provides water for the lower Tarnak area and most of the Central Arghandab areas. The South Canal capacity is about 42.5 m^3/s (1,500 cfs) of which 25.5 m^3/s (900 cfs) was planned for the Tarnak areas. It extends southwesterly for about 17 km (10.6 mi) parallel to the river to a wasteway. Then it runs

in an easterly direction for another 27 km (16.8 mi) where it branches into the South Tarnak and North Tarnak Canals. The South Tarnak Canal extends 21 km (12.4 mi) and has a capacity of 9.2 m^3/s (325 cfs). The North Tarnak Canal extends 11 km (6.8 mi) into the Tarnak area and has a capacity of 17 m^3/s (600 cfs). The canals were not completed and only about 5.1 m^3/s (180 cfs) of water is being used in the Tarnak area.[6/] Nearly all of the South Canal is lined.

6. Other Canals diverting from the Arghandab River - Many other canals divert water from the Arghandab River. There are an estimated 23 on the north side of the river and 13 on the south side between the dam and the junction with the Dori River.[11/] It is estimated that about 18.4 m^3/s (650 cfs) could be diverted into the North Arghandab area by all of the canals, during adequate flow in the Arghandab River. Also, about 5.7 m^3/s (200 cfs) could be diverted by all the canals on the south side of the Arghandab in addition to the South Canal.[6/] Below the junction of the Dori and Arghandab Rivers there are about 15 canals that divert water to the north side of the river and 11 that divert water to the south side of the river.[10/] Total capacity of these 26 canals is not known. The number of diversions and canals above the Arghandab Reservoir is not known.

7. Karezes, springs and wells - A complete inventory of karezes, springs and wells has not been made in the Helmand River Basin. The total number is not known. However, an inventory made in the Zamindawar area gives an indication. There are some 80 Karezes that are active or recently active in the Zamindawar area. The average yield is about 0.01 m^3/s (0.4 cfs). Reportedly the best flows from karezes occurred during 1945 to 1950. Some 25 to 30 springs exist in this area. Discharges from some are as much as 0.11 m^3/s (4.0 cfs) and others are considerably less. The total number of wells in the area is not known. The few that have been inventoried yield very small quantities of water.[19/]

B. Drainage Systems - The total number, length, and capacity of drains and wasteways in the Helmand River Basin is not known. However, some drains have been installed as part of the total irrigation development in project areas and data are available.

There are 753 km (467 mi) of open drains in the drainage network operated and maintained by HAVA. Flows of over 2.0 m^3/s (70 cfs) have been measured in some drains.[18/] In addition there are 189 km (117 mi) of wasteways operated and maintained by HAVA. To this must be added the farmer-built drains that vary from shallow ditches to substantial drains.

C. <u>River Regimes</u> - The Helmand River, of course, is the major stream in the Helmand River Basin. Tributaries to the Helmand River include the Kaj, Tirin, Musa Qala and Arghandab Rivers. The Arghandab River is the largest tributary to the Helmand River and includes the Dori, Arghestan and Tarnak Rivers. The river regime is shown on Figure 4-2.

The main stem of the Helmand River begins west of Kabul on the southern slope of Koh-i-Baba and Paghman Mountains which form part of the Hindu Kush range. The stream begins at an elevation of about 3,600 m (11,800 ft) and leaves the study area near Deshoo at an elevation of about 570 m (1,870 ft). The Helmand River flows nearly 825 km (510 mi) in a southwesterly direction through the study area.

The Kaj River joins the Helmand River 90 km (55 mi) above Kajakai Reservoir at an elevation of 1,110 m (3,640 ft) and the Tirin River enters the Helmand River 50 km (33 mi) above Kajakai at an elevation of 1,060 m (3,480 ft). About 37 km (23 mi) below Kajakai, the Musa Qala River enters the Helmand River at an elevation of 880 m (2,890 ft); and approximately 125 km (80 mi) below Kajakai, the Arghandab River joins the Helmand at an elevation of 764 m (2,510 ft).

The Arghandab is the most important tributary of the Helmand River and is nearly 415 km (260 mi) long. It begins in the mountains southwest of Ghazni at an elevation of about 3,500 m (11,485 ft). It flows southwesterly to a point about 40 km (25 mi) southwest of Kandahar where it is joined by the Dori River and then westerly to its junction with the Helmand River near Qala-i-Bost.

D. Reservoirs - The Kajakai and Arghandab Reservoirs provide the only major surface water storage within the contributing portion of Helmand River Basin. The Kajakai Reservoir is located on the Helmand River about 140 km (87 mi) northeast of Lashkar Gah. The Arghandab Reservoir is located on the Arghandab River about 34 km (21 mi) northeast of Kandahar. [9/] The main purpose for these reservoirs is to store water from snowmelt in the spring and release the water for irrigation during the summer. The reservoirs have also reduced flood flow damages to some extent.

The Kajakai dam was completed in November 1952 and the gates were closed in January 1953. The dam is earthfill construction and rises 85 m (280 ft) above the river bed to a crest elevation of 1,050 m (3,445 ft). It has a crest length of 290 m (950 ft) and a crest width of 10 m (33 ft). [3/] There is an open spillway in the right abutment.

CHAPTER 2

GENERAL BASIN DESCRIPTION

Contents

When the dam was designed, it was anticipated that at some time in the future the spillway would be equipped with gates to increase the operating level in the reservoir so that more water could be stored for irrigation, hydroelectric generation, and flood control. The dam was also provided with a power tunnel so that a power station could easily be constructed when needed.

The spillway channel at the Kajakai dam is about 1,450 m (4,760 ft) long and 114 m (370 ft) wide.[3] At the spillway elevation of 1,033.5 m (3,392 ft) the reservoir had a designed capacity of 1,844,830 Ml (1,495,000 ac-ft). The capacity as of June 1976 is estimated to be 1,640,230 Ml (1,329,200 ac-ft).

The Kajakai reservoir extends 49 km thalweg distance (28 mi) up-stream from the dam. Full capacity widths of the reservoir vary from 200 m (660 ft) in the "narrows" to about 2,400 m (7,870 ft). The reservoir surface area at spillway crest is about 74 km^2 (28.6 mi^2).

Irrigation and normal reservoir releases from Kajakai Reservoir are made through three valves which have a combined discharge capacity of 217 m^3/s (7,660 cfs) when the reservoir is at spillway crest. The spillway is a broad weir with a discharge capacity of 9,910 m^3/s (350,000 cfs).[3,28]

The Arghandab dam was completed in January 1952 and the gates were closed in February 1952. It is earthfill construction 50 m (164 ft) high with a crest elevation of 1,115 m (3,660 ft). The length along the crest is 540 m (1770 ft). There are two uncontrolled rock cut spillways in the right abutment with a low concrete weir in each spillway with a crest elevation of 1,110 m (3,640 ft). The weirs have a combined width of about 332 m (1,090 ft). At the spillway crest elevation, the Arghandab reservoir covers approximately 30 km^2 (11.6 mi^2) and had a designed capacity of 478,800 Ml (388,000 ac-ft.[22/] The capacity as of June 1976 is estimated to be 403,300 Ml (326,800 ac-ft).

Normal discharge from the Arghandab Reservoir is regulated through the valves with a combined capacity of 52 m^3 (1,840 cfs).[9/] The spillway is a weir with a discharge capacity of 2,410 m^3/s (85,000 cfs).[22/]

4.4 WATER SUPPLY

All of the water resources that reach the Helmand River Basin are supplied through precipitation. This comes in the form of rain or snow which eventually reaches the streams as surface water or infiltrates into the soil and becomes ground water.

Some of the water which is diverted from streams for irrigation returns to the streams and thus provides, in effect, a new supply. Therefore quantity of water may not decrease in proportion to the amount diverted between

stream gaging points even though there are no rivers to supply water. However, this return flow usually will be of poorer quality than when it was diverted from the stream.

This relationship of the amount of water diverted, amount used, and amount of return flow is not well known. It is, however, an important factor in a water resource analysis and management.

A. Precipitation - Very little information has been collected concerning rainfall or snowpack depths for the Helmand River Basin. Nothing was found to indicate that an analysis has ever been made to determine the total amount of water which comes as precipitation. However, a very rough estimate based on limited and scattered data gives an annual total of 30,850,000 Ml (25,000,000 ac-ft) of water for the Helmand River Basin.

It is estimated that 76 percent or 23,446,000 Ml (19,000,000 ac-ft) of the total falls in the Mountains Resource Area; 19 percent or 5,861,500 Ml (4,750,000 ac-ft) falls in the Desert Upland Resource Area; and five percent of 1,542,500 Ml (1,250,000 ac-ft) falls in the Desert Plains Resource Area.

The best estimate that can be made on how much water reaches the streams as surface runoff is 8,638,000 Ml (7,000,000 ac-ft). This is based partly on measured streamflow for the major rivers, partly

on correlation with random streamflow measurements for other minor tributaries, and partly on judgment for remaining tributaries. This gives a runoff value of 28 percent for the entire Helmand River Basin.

Only two areas were identified that gave any sort of correlation between the total water received by precipitation and the amount of water reaching the streams as surface runoff. These were the watersheds above Kajakai and Arghandab Reservoirs.

It is estimated that annually about 15,671,800 Ml (12,700,000 ac-ft) of water falls as precipitation on the watershed above Kajakai Reservoir. Of this amount approximately 6,124,300 Ml (4,963,000 ac-ft) or 39 percent of the precipitation runs off into the Reservoir. This means that about 9,547,500 Ml (7,737,000 ac-ft) either evaporates, migrates into the ground water, or is used by on-site vegetation.

Annually about 4,072,200 Ml (3,300,000 ac-ft) of water falls as precipitation on the watershed above the Arghandab Reservoir and approximately 1,251,300 Ml (1,014,000 ac-ft) runs into the Reservoir. This is a runoff value of 30 percent and means that about 2,820,900 Ml (2,286,000 ac-ft) of water enters into the ground water, evaporates, or is used by on-site vegetation.

B. Surface Water - This is the primary supply of water to irrigated cropland. While some ground water is used throughout the Helmand River Basin, withdrawal is less than nine percent of the amount diverted from surface water. Direct use from streamflow is made along all rivers, but the supply is supplemented by reservoir storage.

The water in the Helmand and Arghandab Rivers is of good to excellent quality for irrigation purposes. The water is low in soluble salts and has a low sodium content. The sodium adsorption-ratio (SAR) is very low, and assuming precipitation of all carbonates and bicarbonate as insoluble calcium and magnesium carbonates, there will be no residual sodium carbonate.[9/]

Return flow from drains is usually of poorer quality than the irrigation water and is frequently unusable unless it is mixed with better quality water. As more land is brought into production and more water is diverted for irrigation, the amount of return flow will probably increase and the quality of the return flow will decrease. Because return flow enters all along the river, water quality decreases downstream. At some point on the river the water may become unusable for irrigation.

1. Streamflow - Measurements are not available for all of the streams which supply water. However, it is estimated that over 90 percent of the water in streams is measured. A correlation

with these measurements gives approximately 8,638,000 Ml (7,000,000 ac-ft) of water supplied by streamflow.

Streamflow at various gaging stations in the Helmand River Basin are shown in Table 4-3 for the available years of record. The average annual flow for recent years of record at these same stations are recorded graphically in Figure 4-4. A comparison of streamflow below Kajakai and at Lashkar Gah shows some reduction in flow due mainly to diversions to irrigated cropland, although some is lost to evaporation and ground water recharge. There is usually more water at Darweshan than is released from Kajakai Reservoir due mainly to the inflow from the Arghandab River below Lashkar Gah.

Examination of streamflow records for the Helmand and Arghandab Rivers shows that since 1947, there was a drought in 1971 and an extremely wet year in 1957. The approximate return period for the hydrologic condition of 1971 is one in 30 years.[14]

The time distribution of the Helmand River streamflow above Dehraout is typical of snowmelt fed, unregulated streams, with peak flows in April and May and minimum flows during the winter months. This flow pattern is quickly modified in watershed areas

Table 4-3 Average Annual Streamflow at Selected Gaging Stations, Helmand River Basin in Megaliters [7,11] /a

USGS Station Number	Name and Location	All Available Years Water Year(b)	All Available Years Annual Flow	Recent Years Water Year(b)	Recent Years Annual Flow
7000.10	Helmand River near Ghizab	1971-74	2,280,600 (1,848,100)	1971-74	2,280,600 (1,848,100)
7000.20	Helmand River near Dehraout	1953-75	5,554,500 (4,501,200)	1970-75	4,341,100 (3,517,900)
7000.30	Helmand River below Kajakai Dam	1948-75	6,000,600 (4,862,700)	1970-75	4,834,100 (3,917,400)
7000.40	Helmand River at Lashkar Gah	1954-56 73-74	5,238,900 (4,245,500)	1973-74	4,028,800 (3,264,800)
7000.50	Helmand River at Darweshan	1957-75	6,073,300 (4,921,600)	1970-75	4,222,400 (3,421,700)
7000.60	Helmand River at Malakhan	1970-74	4,048,100 (3,280,500)	1970-74	4,048,100 (3,280,500)
7400.90	Kaj River at Kshi near Kajiron	1970-75	661,100 (535,700)	1970-75	661,100 (535,700)
7500.30	Tirin River near Tirinkot	1970-73	319,200 (258,700)	1970-73	319,200 (258,700)
7500.80	Tirin River at Anar Joi	1961-75	423,300 (343,000)	1970-75	439,700 (356,300)
7500.90	Tirin River near Dehraout	1953-68	489,000 (396,300)	(c) (c)	(c) (c)
7600.90	Musa Qala at Musa Qala	1953-67 70-72	215,300 (174,500)	1970-72	75,400 (61,100)
7800.20	Arghandab River near Sang-i-Masha	1970-75	250,100 (202,700)	1970-75	250,100 (202,700)
7800.50	Arghandab River above Arghandab Reservoir	1948-75	1,251,300 (1,014,000)	1970-75	1,059,400 (858,500)
7800.60	Arghandab River below Arghandab Reservoir	1948-75	1,224,300 (992,100)	1970-75	1,007,900 (816,800)
7800.70	Arghandab River near Kandahar	1970-74	342,900 (277,900)	1970-74	342,900 (277,900)
7800.90	Arghandab River near Qala-i-Bost	1948-72	817,800 (662,700)	1970-72	319,600 (259,000)
7887.90	Arghestan River near Kandahar	1952-68(d)	154,500 (125,200)	(c) (c)	(c) (c)

(a) Values in parentheses are ac-ft
(b) Years given are inclusive
(c) No recent records
(d) Four years missing during this period

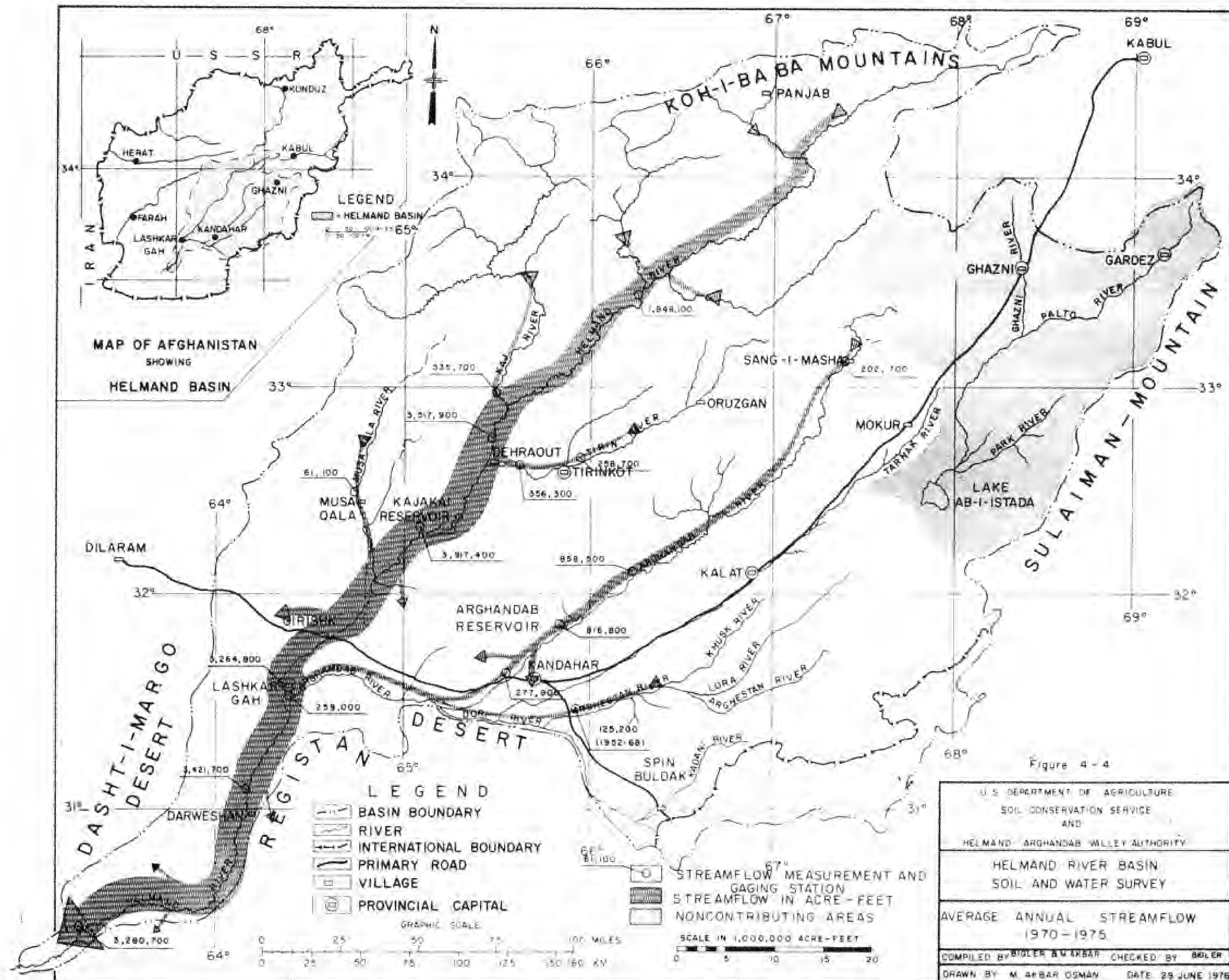

MAP OF AFGHANISTAN
SHOWING
HELMAND BASIN
U S S R
IRAN
KUNDUZ
HERAT
KABUL
GHAZNI
FARAH
LASHKAR GAH
KANDAHAR
LEGEND
= HELMAND BASIN
N
KOH-I-BABA MOUNTAINS
PANJAB
KABUL
GHAZNI
GARDEZ
SANG-I-MASHA
ORUZGAN
MOKUR
DEHRAOUT
TIRINKOT
MUSA QALA
KAJAKAI RESERVOIR
DILARAM
GIRISHK
ARGHANDAB RESERVOIR
KANDAHAR
KALAT
LAKE AB-I-ISTADA
SULAIMAN MOUNTAIN
LASHKAR GAH
DASHT-I-MARGO DESERT
REGISTAN DESERT
SPIN BULDAK
DARWESHAN
HELMAND RIVER
KAJ RIVER
MUSA QALA RIVER
TIRIN RIVER
ARGHANDAB RIVER
GHAZNI RIVER
PALTO RIVER
PARK RIVER
TARNAK RIVER
KHUSK RIVER
LORA RIVER
ARGHESTAN RIVER
DORI RIVER
KADAN RIVER
1,848,100
335,700
3,517,900
61,100
258,700
356,300
202,700
3,917,400
858,500
816,800
3,264,800
259,000
277,900
125,200
(1952-68)
3,421,700
3,280,700
81,100
LEGEND
BASIN BOUNDARY
RIVER
INTERNATIONAL BOUNDARY
PRIMARY ROAD
VILLAGE
PROVINCIAL CAPITAL
STREAMFLOW MEASUREMENT AND GAGING STATION
STREAMFLOW IN ACRE-FEET
NONCONTRIBUTING AREAS
GRAPHIC SCALE
0 25 50 75 100 MILES
0 25 50 75 100 125 150 160 KM
SCALE IN 1,000,000 ACRE-FEET
0 5 10 15 20
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AND
HELMAND ARGHANDAB VALLEY AUTHORITY
HELMAND RIVER BASIN
SOIL AND WATER SURVEY
AVERAGE ANNUAL STREAMFLOW
1970-1975
COMPILED BY BIGLER & M AKBAR
CHECKED BY BIGLER
DRAWN BY M. AKBAR OSMAN
DATE 29 JUNE 1976

Figure 4-4

below 1,500 m (4,920 ft) where runoff from rainfall enters the streams and is even more pronounced below Kajakai Reservoir by the Musa Qala River which peaks in March and reaches a low flow in September and October.

Generally, over one-half of the total annual surface water flow occurs during April and May. The amounts are about equal for each month. Minimum amounts flow during September and October when about six percent of the total annual flow occurs. For the 1970 through 1974 period an average of 4,248,100 Ml (3,280,500 ac-ft) flows past Malakhan and out of the study area.

Above Kajakai the average peak flow month for the 1947 through 1975 period is about nine times greater than the low flow month. However, above the Arghandab Reservoir the average peak flow month is 17 times greater than the low flow month.

2. Kajakai Reservoir - The Helmand River receives a fairly high degree of regulation by the Kajakai Reservoir. When constructed, Kajakai Reservoir capacity was estimated at 1,844,830 Ml (1,495,000 ac-ft). The storage capacity as of June 1976 is estimated at 1,640,233 Ml (1,329,200 ac-ft).

The average annual inflow to Kajakai Reservoir for the 28 year period, 1947 through 1975 is 6,124,000 Ml (4,963,000 ac-ft).

The average annual maximum inflow in 1957 of 11,179,000 Ml (9,059,000 ac-ft) is nearly five times the annual minimum inflow of 2,341,000 Ml (1,896,900 ac-ft) in 1971. This is shown in Table 4-4 and in Figure 4-5.

The maximum monthly inflow for this period of record occurred in May of 1957 and the minimum flow occurred in August of 1971. These volumes were 3,155,000 Ml (2,557,000 ac-ft) and 66,800 Ml (54,100 ac-ft) respectively. Peak flow of 2,317,200 Ml (1,877,800 ac-ft) occurred in April 1976.

3. Arghandab Reservoir - The Arghandab Reservoir had an original design capacity of 478,800 Ml (388,000 ac-ft). The estimated capacity in June 1976 was 403,300 Ml (326,800 ac-ft).

The average annual inflow to Arghandab Reservoir for the 28-year period, 1947 through 1975, is 1,251,300 Ml (1,014,000 ac-ft). The average annual maximum inflow in 1957 of 2,675,300 Ml (2,168,000 ac-ft) is ten times the annual minimum inflow of 268,500 Ml (217,600 ac-ft) in 1971. Average annual inflow is given in Table 4-5 and in Figure 4-6.

The maximum monthly inflow to Arghandab Reservoir was 857,500 Ml (694,800 ac-ft) which occurred in April of 1957. In July of 1971, there was no measurable inflow to the Arghandab Reservoir.

Figures

Tables

Table 4-4a Average Annual Inflow to Kajakai Reservoir 1947-1975, in 1,000 Megaliters 10,28/

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1947-48	109.8	140.4	165.5	161.5	180.9	739.9	1,565.9	103.0	334.5	165.9	104.0	109.9	4,800.5
1948-49	148.7	176.8	192.1	193.5	276.2	882.7	2,260.7	1,261.1	461.4	239.8	166.7	149.0	6,408.8
1949-50	193.0	217.4	231.4	275.0	279.7	647.8	1,263.6	2,101.5	749.2	300.6	154.7	147.0	6,486.0
1950-51	187.6	197.7	203.2	210.6	218.8	829.9	1,649.9	2,464.3	940.3	352.1	190.4	170.4	7,615.1
1951-52	193.7	221.3	233.0	243.1	371.1	929.9	1,686.9	1,134.7	429.2	216.4	143.3	154.4	5,957.0
1952-53	198.0	214.3	218.8	209.3	296.5	963.4	1,174.6	913.5	479.5	167.8	147.6	143.9	5,127.4
1953-54	176.7	187.6	204.2	264.7	394.8	1,032.2	1,780.5	1,472.4	578.6	340.0	200.0	183.4	6,815.2
1954-55	224.1	242.6	234.8	219.2	202.6	729.3	805.6	1,036.7	502.7	219.8	136.7	130.0	4,684.1
1955-56	169.9	175.7	225.3	242.5	271.0	1,109.9	2,668.4	1,224.3	389.1	485.8	200.8	182.5	7,345.2
1956-57	212.0	228.2	220.3	294.3	328.0	1,398.1	3,007.1	3,155.3	1,285.0	530.4	290.9	230.1	11,179.7
1957-58	296.8	385.0	458.6	446.5	476.9	990.5	1,585.3	1,004.1	520.3	281.0	206.2	197.0	6,848.2
1958-59	221.3	225.8	274.9	275.4	291.1	1,215.6	1,586.9	1,000.9	432.1	260.1	202.4	187.0	6,173.7
1959-60	197.8	247.9	309.2	260.9	293.1	533.2	1,225.7	1,572.1	591.8	264.0	179.9	166.6	5,842.9
1960-61	196.8	217.7	218.0	215.2	204.4	553.2	1,941.0	1,638.8	529.5	256.4	189.0	176.7	6,336.7
1961-62	193.9	225.3	238.3	225.0	230.6	436.7	888.1	738.3	306.9	161.3	136.9	137.7	3,918.9
1962-63	161.9	172.9	181.8	176.5	189.9	338.2	587.6	1,243.5	540.2	210.6	153.8	127.7	4,073.6
1963-64	167.1	218.3	221.4	213.5	328.2	967.2	1,957.7	1,274.7	467.9	239.9	158.6	147.5	6,362.0
1964-65	191.4	209.5	228.2	354.0	551.7	1,180.4	2,168.3	2,528.8	1,203.1	527.0	326.1	244.1	9,712.8
1965-66	274.1	275.8	256.8	270.1	296.4	374.0	935.0	779.3	336.5	183.7	129.8	131.2	4,225.2
1966-67	263.9	186.0	177.6	205.3	197.3	232.1	1,042.6	2,086.3	834.0	572.3	536.7	308.6	6,642.9
1967-68	255.6	272.2	287.3	462.1	474.3	589.9	633.8	1,406.5	760.6	572.9	552.7	350.6	6,617.7
1968-69	286.2	267.0	274.7	268.4	519.9	1,364.4	2,180.0	1,543.5	874.8	413.0	240.4	215.5	8,447.7
1969-70	240.1	393.6	298.9	304.0	282.8	506.4	989.0	580.8	219.3	140.0	130.7	113.3	4,199.2
1970-71	155.6	178.2	190.9	180.8	203.0	318.7	510.1	263.8	110.8	75.9	66.8	86.1	2,340.8
1971-72	125.1	149.3	152.8	199.2	212.5	1,155.0	1,831.1	1,577.3	671.3	291.5	178.3	164.0	6,707.4
1972-73	201.3	229.6	275.7	260.4	445.4	963.4	1,503.5	960.0	316.2	174.0	118.0	142.9	5,590.3
1973-74	199.3	191.7	209.3	276.2	278.5	916.7	1,141.3	632.5	246.3	130.1	104.4	119.3	4,445.2
1974-75	171.6	190.9	234.1	218.2	348.5	800.9	1,826.3	1,647.6	572.6	260.4	156.7	155.7	6,583.5
1975-76	230.5	276.2	253.4	361.6	1,032.6	2,697.5	2,317.2						
Total	5,818.9	6,469.0	6,893.9	7,378.8	9,005.7	23,680.8	45,083.2	40,579.7	15,683.9	7,994.5	5,501.9	4,772.4	171,487.4
Ave.	200.6	223.1	237.7	254.5	310.6	816.5	1,554.6	1,399.4	560.1	285.5	196.5	170.4	6,124.6

Table 4-4b Average Annual Inflow to Kajakai Reservoir, 1947-1975 (1,000 ac-ft) 10,28/

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1947-48	89.0	113.8	134.1	130.9	146.6	599.6	1,269.0	828.2	271.1	134.5	84.3	89.1	3,890.2
1948-49	120.5	143.3	155.7	156.8	223.8	715.3	1,832.0	1,022.0	373.9	194.3	135.1	120.8	5,193.5
1949-50	156.4	176.2	187.5	222.9	226.7	483.4	1,024.0	1,703.0	607.1	224.3	125.4	119.1	5,256.0
1950-51	152.0	160.2	164.7	170.7	177.3	672.5	1,337.0	1,997.0	762.0	285.3	154.3	138.1	6,171.1
1951-52	157.0	179.3	188.8	197.0	300.7	753.6	1,367.0	919.5	347.8	175.4	116.1	125.1	4,827.3
1952-53	160.5	173.7	177.3	169.6	240.3	780.7	951.9	740.3	388.6	136.0	119.6	116.6	4,155.1
1953-54	143.2	152.0	165.5	214.5	319.9	836.5	1,442.9	1,193.2	468.9	275.5	162.1	148.6	5,522.8
1954-55	181.6	196.6	190.3	177.6	164.2	591.0	652.8	840.1	407.4	178.1	110.8	105.4	3,795.9
1955-56	137.7	142.4	182.6	196.5	219.6	899.4	2,162.4	992.1	315.3	393.7	162.7	147.9	5,952.3
1956-57	171.8	184.9	178.5	238.5	265.8	1,133.0	2,436.9	2,557.0	1,041.3	429.8	235.7	186.5	9,059.7
1957-58	240.5	312.0	371.6	361.8	386.5	802.7	1,284.7	813.7	421.6	227.7	167.1	159.7	5,549.6
1958-59	179.3	183.0	222.8	223.2	235.9	985.1	1,286.0	811.1	350.2	210.8	164.0	151.6	5,003.0
1959-60	160.3	200.9	250.6	211.4	237.5	432.1	993.3	1,274.5	479.6	213.9	145.8	135.0	4,734.9
1960-61	159.5	176.4	176.7	174.4	165.6	448.3	1,572.9	1,328.0	429.1	207.8	153.2	143.2	5,135.1
1961-62	157.1	182.6	193.1	182.3	186.9	353.9	719.7	598.3	248.7	130.7	110.9	111.6	3,175.8
1962-63	131.2	140.1	147.3	143.0	153.9	274.1	467.2	1,007.7	437.8	170.7	124.6	103.5	3,301.1
1963-64	135.4	176.9	179.4	173.0	266.0	783.8	1,586.5	1,033.0	379.2	194.4	128.5	119.5	5,155.6
1964-65	155.1	169.8	184.9	286.9	447.1	956.6	1,757.1	2,049.3	975.0	427.1	264.3	197.8	7,871.0
1965-66	222.1	223.5	208.1	218.9	240.2	303.1	757.7	629.1	272.7	137.1	105.2	106.3	3,424.0
1966-67	213.9	150.7	143.9	166.4	159.9	188.1	844.9	1,690.7	675.9	463.8	434.9	250.1	5,383.2
1967-68	207.1	220.6	232.8	374.5	384.4	477.7	513.6	1,139.8	616.4	464.3	447.5	284.1	5,362.8
1968-69	231.9	216.4	222.6	217.5	421.3	1,105.7	1,766.6	1,250.8	708.9	334.7	194.8	174.6	6,845.8
1969-70	194.6	319.0	242.2	246.4	229.2	410.4	801.5	470.7	177.7	113.5	105.9	91.8	3,402.9
1970-71	126.1	144.4	154.7	146.5	164.5	258.3	413.4	213.8	89.8	61.5	54.1	69.8	1,896.9
1971-72	101.4	121.0	123.8	161.4	172.2	936.0	1,483.9	1,278.2	544.0	236.2	144.5	132.9	5,435.5
1972-73	163.1	186.1	223.4	211.0	360.9	780.7	1,218.4	778.0	256.2	141.0	95.6	115.8	4,530.2
1973-74	161.5	155.0	169.6	223.8	225.7	742.9	924.9	512.6	199.6	105.4	84.6	96.7	3,602.3
1974-75	139.1	154.7	189.7	176.8	282.4	649.0	1,480.0	1,335.2	464.0	211.0	127.0	126.2	5,335.1
1975-76	166.6	186.8	223.8	205.4	293.0	836.8	2,186.0	1,877.8					
Total	4,715.5	5,242.3	5,586.6	5,979.6	7,298.0	19,190.3	36,534.2	32,884.7	12,709.8	6,478.5	4,458.6	3,867.4	138,968.7
Ave.	162.6	180.8	192.6	206.2	251.7	661.7	1,259.8	1,134.0	453.9	231.4	159.2	138.1	4,963.2

Table 4-5a Average Annual Inflow to Arghandab Reservoir, 1947-1975 in 1,000 Megaliters 10,29/

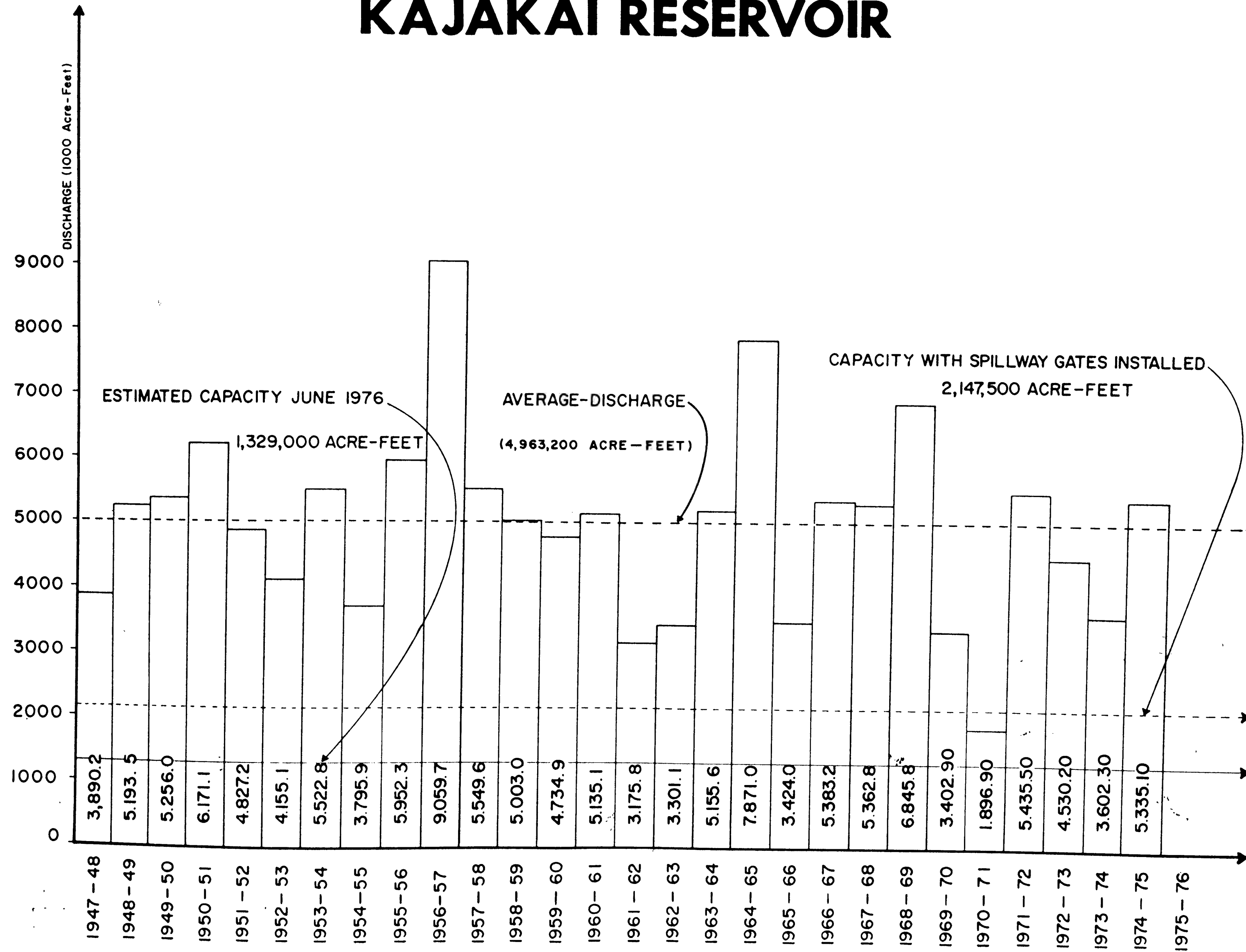
Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1947-48	11.7	19.6	39.5	29.9	33.8	178.9	229.4	94.0	32.6	18.1	12.3	7.3	708.2
1948-49	15.4	27.4	36.4	41.7	42.8	362.1	334.5	114.3	40.4	21.7	27.1	13.3	1,077.2
1949-50	24.3	32.3	37.9	117.6	86.6	167.7	403.3	352.8	92.3	43.7	31.0	23.3	1,412.8
1950-51	29.4	39.9	49.2	48.0	58.6	178.1	321.1	372.8	99.1	42.0	25.8	23.2	1,287.1
1951-52	25.9	34.9	42.3	48.9	84.9	199.2	298.8	137.5	46.8	34.4	28.4	22.6	1,007.4
1952-53	25.9	34.6	39.0	38.5	115.5	134.9	98.0	57.3	35.7	12.3	8.8	9.3	609.6
1953-54	17.2	26.3	34.2	42.0	200.5	365.6	494.5	279.9	89.0	57.3	33.1	25.8	1,675.9
1954-55	36.0	45.5	48.4	50.5	40.2	134.9	79.7	79.7	31.6	11.7	8.1	6.2	572.6
1955-56	15.8	24.8	58.7	55.3	85.1	459.4	643.7	225.7	83.0	279.1	77.0	36.9	2,044.6
1956-57	46.4	56.5	51.7	93.4	147.7	433.0	857.4	551.0	224.1	109.3	57.6	47.1	2,675.3
1957-58	49.7	108.5	145.0	153.5	150.5	197.8	250.3	156.6	63.6	59.6	26.2	20.0	1,381.5
1958-59	32.3	43.2	56.0	58.5	76.0	500.9	356.7	183.2	74.8	64.0	26.4	26.8	1,498.9
1959-60	31.6	62.6	71.8	57.9	60.3	108.3	344.8	293.9	90.2	49.5	25.5	21.6	1,218.1
1960-61	31.2	42.2	44.5	43.8	41.1	113.5	529.9	338.1	94.2	64.8	33.2	23.0	1,399.5
1961-62	35.0	51.6	56.8	47.5	43.1	79.6	191.0	101.2	23.3	15.3	10.0	11.1	665.5
1962-63	24.4	28.3	36.5	33.3	31.8	53.9	148.5	263.1	109.6	26.8	17.9	16.7	790.7
1963-64	23.4	35.7	41.8	48.0	100.4	283.3	368.5	175.8	57.6	32.8	22.3	15.8	1,205.6
1964-65	69.1	41.1	92.1	145.7	229.4	324.7	641.7	512.0	185.5	90.0	62.3	43.3	2,444.8
1965-66	43.4	62.9	70.1	62.7	67.9	104.1	178.8	141.8	42.8	23.1	15.2	14.8	832.6
1966-67	32.6	36.6	40.7	38.4	42.7	228.9	500.8	463.4	79.2	79.1	47.4	33.4	1,622.7
1967-68	43.6	51.6	61.1	71.7	129.3	416.6	339.5	243.1	105.0	45.7	4.3	24.8	1,560.9
1968-69	34.3	40.2	93.4	104.9	60.3	213.7	199.3	115.6	58.4	33.8	17.8	17.2	988.9
1969-70	27.0	62.9	55.9	59.4	54.3	172.6	237.1	111.3	34.4	19.3	31.5	17.5	883.2
1970-71	24.1	29.1	39.5	36.9	40.0	55.0	32.8	6.7	2.3	0.0	0.4	1.6	268.5
1971-72	3.2	12.3	24.3	46.2	58.6	621.7	505.9	278.9	76.6	44.5	28.0	22.3	1,722.7
1972-73	31.3	42.2	63.8	71.1	127.1	276.4	261.6	114.9	33.2	61.7	18.0	14.8	1,116.2
1973-74	24.4	34.9	70.8	69.4	124.6	318.9	226.1	100.4	39.7	23.1	17.5	12.8	1,062.7
1974-75	17.5	34.2	79.5	62.8	106.9	260.6	347.9	215.0	74.9	44.9	40.4	18.3	1,302.7
1975-76	27.0	44.2	55.8	56.4	159.1	570.1	788.5	417.9					
Total	858.0	1,213.6	1,639.9	1,844.7	2,599.7	7,515.6	10,086.3	6,552.0	2,019.8	1,407.6	778.2	570.7	47,376.3
Ave.	29.6	41.8	56.5	63.7	89.6	259.1	347.9	225.9	72.2	50.2	27.8	20.4	1,251.3

Table 4-5b Average Annual Inflow to Arghandab Reservoir, 1947-1975 in 1,000 ac-ft [10,29]

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1947-48	9.5	15.9	32.0	24.2	27.4	145.8	185.9	76.2	26.4	14.7	10.0	5.9	573.9
1948-49	12.5	22.2	29.5	33.8	34.7	293.4	271.1	92.6	32.7	17.6	22.0	10.8	872.9
1949-50	19.7	26.2	30.7	95.3	70.2	135.9	326.8	285.9	74.8	35.4	25.1	18.9	1,144.9
1950-51	23.8	32.3	39.9	38.9	47.5	144.3	260.2	302.1	80.3	34.0	20.9	18.8	1,043.0
1951-52	21.0	28.3	36.7	39.6	68.8	161.4	242.1	111.4	37.9	27.9	23.0	18.3	816.4
1952-53	21.0	28.0	31.6	31.2	93.6	109.3	79.4	46.4	28.9	10.0	7.1	7.5	494.0
1953-54	13.6	21.3	27.7	43.0	162.5	296.3	400.7	226.8	72.1	46.4	26.8	20.9	1,358.1
1954-55	29.2	36.2	39.2	40.9	32.6	109.3	64.6	64.6	25.6	9.5	6.6	5.0	464.0
1955-56	12.8	20.1	47.6	44.8	69.0	372.3	521.6	182.9	67.3	226.2	62.4	29.9	1,656.9
1956-57	37.6	45.8	41.9	75.7	119.7	350.9	694.8	446.5	181.6	88.6	46.7	38.2	2,168.0
1957-58	40.3	87.9	117.5	124.4	122.2	160.3	202.8	126.9	51.5	48.3	21.2	16.2	1,119.5
1958-59	26.2	35.0	45.4	47.4	61.6	405.9	289.1	148.5	60.6	51.9	21.4	21.7	1,214.7
1959-60	25.6	50.7	58.2	46.9	48.9	87.8	279.4	238.2	73.1	40.1	20.7	17.5	987.1
1960-61	25.3	34.2	36.1	35.5	33.3	92.0	429.4	274.0	76.3	52.5	26.9	18.6	1,134.1
1961-62	28.4	41.8	46.0	38.5	34.9	64.5	154.8	82.0	18.9	12.4	8.1	9.0	539.3
1962-63	19.8	22.9	29.6	27.0	25.8	43.7	120.3	213.2	88.8	21.7	14.5	13.5	640.8
1963-64	19.0	28.9	33.9	38.9	81.4	229.6	298.6	142.5	46.7	26.6	18.1	12.8	977.0
1964-65	56.0	39.8	74.6	118.1	185.9	263.1	520.0	414.9	150.3	72.9	50.5	35.1	1,981.2
1965-66	39.2	51.0	56.8	50.8	55.0	84.4	144.9	114.9	34.7	18.7	12.3	12.0	674.7
1966-67	26.4	29.3	33.0	31.1	34.6	185.5	405.8	375.5	64.2	64.1	38.4	27.1	1,315.0
1967-68	35.3	41.8	49.5	58.1	104.8	337.6	275.1	197.0	85.1	37.0	23.5	20.1	1,264.9
1968-69	27.8	32.6	75.7	85.0	48.9	173.2	161.5	93.7	47.3	27.4	14.4	13.9	801.4
1969-70	21.9	51.0	45.3	48.1	44.0	139.9	192.1	90.2	27.9	15.6	25.5	14.2	715.7
1970-71	19.5	23.6	32.1	29.9	32.4	44.6	26.6	5.4	1.9	0	0.3	1.3	217.6
1971-72	2.6	10.0	19.7	37.4	47.5	503.8	410.0	226.0	62.1	36.1	22.7	18.1	1,396.0
1972-73	25.4	34.2	51.7	57.6	103.0	224.0	212.0	93.1	26.9	50.0	14.6	12.0	904.5
1973-74	19.8	28.3	57.4	56.2	101.0	258.4	183.2	81.4	32.2	18.7	14.2	10.4	861.2
1974-75	14.2	27.7	64.4	50.9	86.6	211.2	281.9	174.2	60.7	36.4	32.7	14.8	1,055.7
1975-76	21.9	35.8	45.2	45.7	128.9	462.0	639.0	382.4					
Total	695.3	983.5	1,328.9	1,494.9	2,106.7	6,090.4	8,173.7	5,309.6	1,636.8	1,140.7	630.6	462.5	38,392.5
Ave.	24.0	33.9	45.8	51.6	72.6	210.0	281.9	183.1	58.5	40.7	22.5	16.5	1,014.0

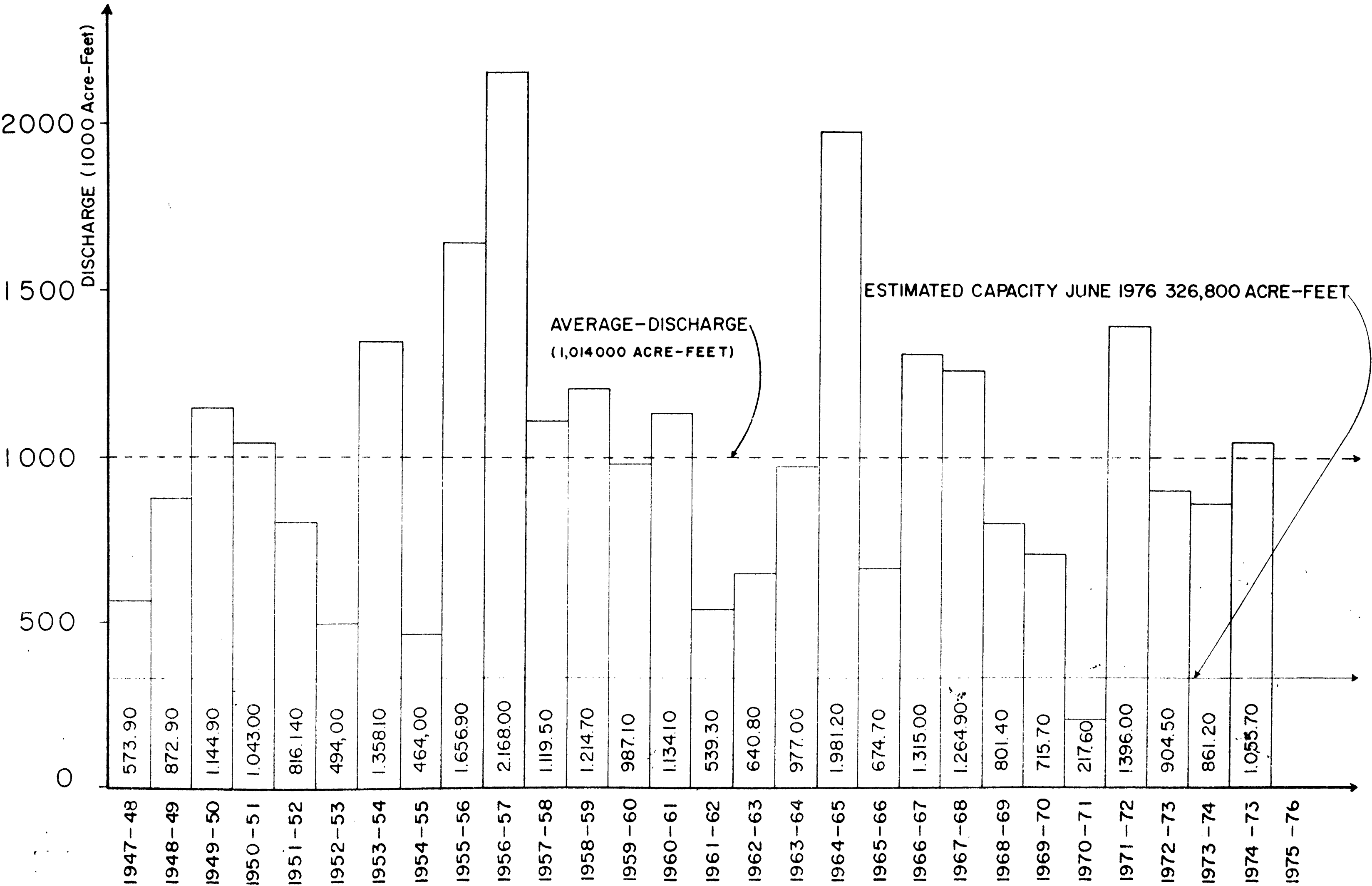
AVERAGE ANNUAL INFLOW TO KAJAKAI RESERVOIR

Figure 4 – 5



AVERAGE ANNUAL INFLOW TO ARGHANDAB RESERVOIR

Figure 4-6



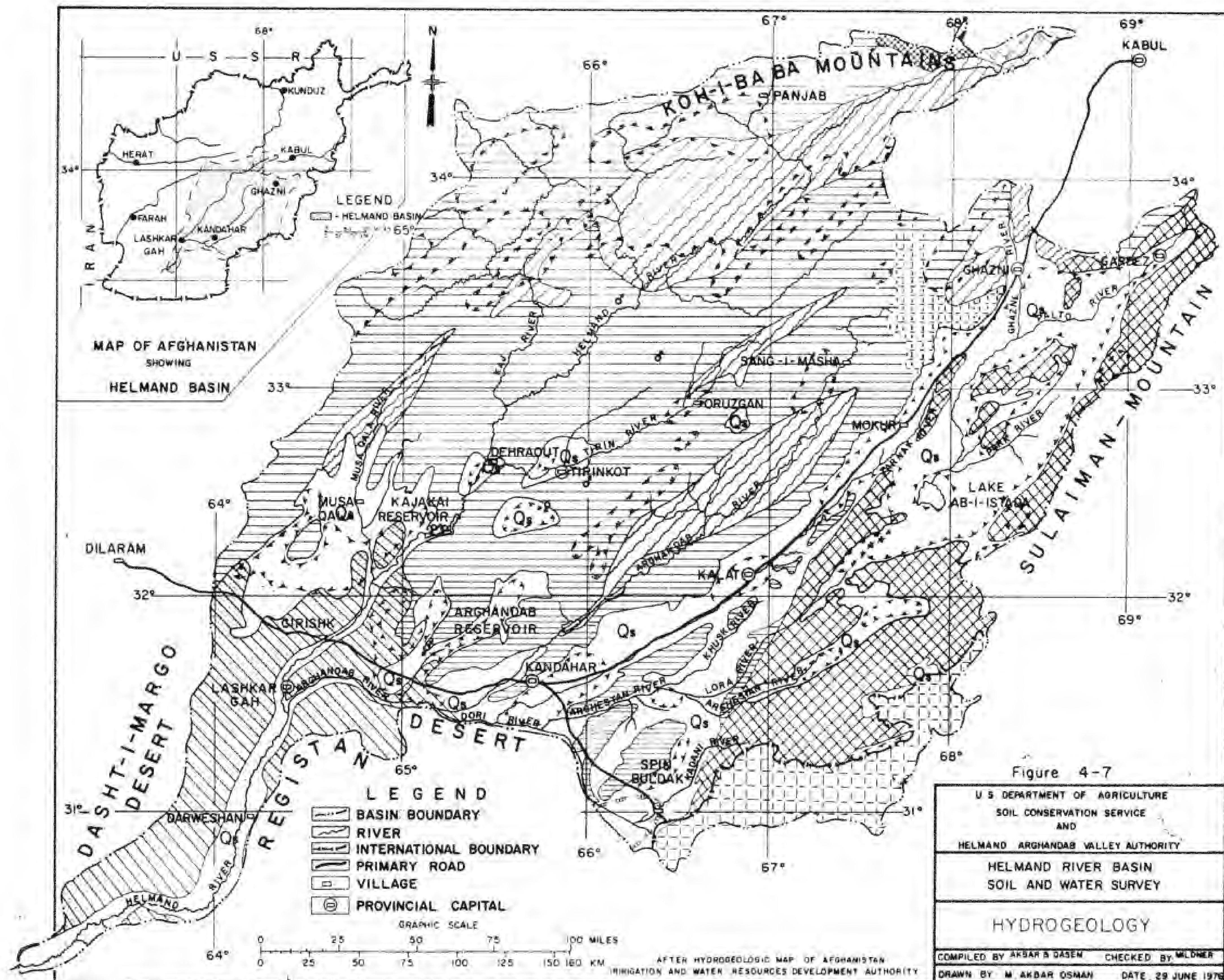
C. Ground Water - Ground water is a virtually untapped resource within the basin. Basin-wide very little is known about the water supplied from ground water.

1. Quantity - Probably less than 40 deep wells have been drilled within the basin of which at least six were in the non-contributing Ghazni area.

Prior to 1971, use of ground water in the Kandahar area was limited to withdrawals from about 20 drilled wells, 46 karezes and an undetermined number of domestic and village wells. The total annual withdrawal from these sources is estimated to have been about 32,100 Ml (26,000 ac-ft).[26/]

In the Zamindawar area there are 80 inventoried karezes, 15 springs, six wells and an undetermined number of uninventoried karezes. These sources have an estimated annual withdrawal of 37,000 Ml (30,000 ac-ft).[19/]

Assuming these areas furnished 20 percent of the total used from ground water sources in the basin, it can be computed that total withdrawal for irrigation, domestic supplies, and stock water is 345,500 Ml (280,000 ac-ft). Figure 4-7 shows the general hydrologic conditions for the basin and the areas of ground water exploitation by karezes. To date, karezes are the principal method of ground water exploitation.



U S S R
KUNDUZ
HERAT
KABUL
GHAZNI
FARAH
LASHKAR GAH
KANDAHAR
IRAN
LEGEND
HELMAND BASIN
MAP OF AFGHANISTAN
SHOWING
HELMAND BASIN
N
KOH-I-BABA MOUNTAINS
PANJAB
KABUL
GHAZNI
GARDEZ
SANG-I-MASHA
ORUZGAN
MOKUR
DEHRAOUT
TIRINKOT
MUSA QALA
KAJAKAI RESERVOIR
LAKE AB-I-ISTADA
SULAIMAN MOUNTAIN
DILARAM
KALAT
ARGHANDAB RESERVOIR
GIRISHK
KANDAHAR
LASHKAR GAH
DORI RIVER
ARGHESTAN RIVER
LORA RIVER
KADANI RIVER
SPIN BULDAK
DARWESHAN
REGISTAN DESERT
DASHT-I-MARGO DESERT
HELMAND RIVER
ARGHANDAB RIVER
TARNAK RIVER
TIRIN RIVER
KAJ RIVER
MUSA QALA RIVER
GHAZNI RIVER
KHUSK RIVER
Qs
LEGEND
BASIN BOUNDARY
RIVER
INTERNATIONAL BOUNDARY
PRIMARY ROAD
VILLAGE
PROVINCIAL CAPITAL
GRAPHIC SCALE
0 25 50 75 100 MILES
0 25 50 75 100 125 150 160 KM
AFTER HYDROGEOLOGIC MAP OF AFGHANISTAN
IRRIGATION AND WATER RESOURCES DEVELOPMENT AUTHORITY
Figure 4-7
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AND
HELMAND ARGHANDAB VALLEY AUTHORITY
HELMAND RIVER BASIN
SOIL AND WATER SURVEY
HYDROGEOLOGY
COMPILED BY AKSAR B DASEN CHECKED BY MILDNER
DRAWN BY M AKBAR OSMAN DATE 29 JUNE 1976

2. Quality - About the only fact that can be stated with assurance is that quality of ground water is generally poorer than that of river water. From the available evidence it is concluded that the quality of water in wells reflects the general quality of ground water in the vicinity of the well and is strongly dependant on the specific local conditions of recharge. Wells situated where they intercept water of good original quality, which does not drain through extensive irrigated areas, are most likely to produce water of good quality. Deep wells may encounter relatively good water in areas where the shallow ground water is of poor quality.

4.5 WATER USE

Water is used in a variety of ways. It is used by vegetation on site where it falls as precipitation or it is used by vegetation on areas where it has been diverted. Water evaporates back into the atmosphere from water surfaces. It migrates into the ground and recharges the ground water. It is used for hydroelectric power generation and it is used by industries and villages for other purposes.

A. On-Site - The use of water by native vegetation can be considerable, especially in areas where heavy growth of vegetation occurs. A very rough estimate based on limited and scattered data gives 10,240,000 Ml (8,300,000 ac-ft) of on-site use in the Mountains

Resource Area; 3,830,000 Ml (3,100,000 ac-ft) in the Desert Upland Area; and 1,230,000 Ml (1,000,000 ac-ft) in the Desert Plains Resource Area.

In the Mountains Resource Area the amount of precipitation is more than the native vegetation can use and it is estimated that approximately 34 percent of the water reaches the streams and rivers as surface runoff.

The Desert Upland Resource Area receives more water from precipitation than the soil can absorb and runoff occurs. About 10 percent of the precipitation reaches the streams as surface runoff. From April through November, very little runoff occurs.

In the Desert Plains Resource Area the use by vegetation is practically equal to the rainfall. Very little runoff volume occurs that is of beneficial use for storage or irrigation. Occasional high flood peaks occur, but the associated volume of runoff is usually very small and is usually lost to on-site use as well.

B. Evaporation - Annual water surface evaporation based on the pan method varies from as much as 2,990 mm (118 in) in the Desert Plains Resource Area to 2,300 mm (90 in) in the Desert Upland Resource Area to 1,400 mm (55 in) in the Mountains Resource Area. Average monthly evaporation is given in Table 2-4. With the exception of

CHAPTER 2

GENERAL BASIN DESCRIPTION

2.1 PHYSICAL DESCRIPTION OF THE BASIN

This chapter will give the reader a general understanding of many general topics which relate to the development of the soil and water resources within the Helmand River Basin. It presents a discussion of the resource areas, climate, vegetation, population, roads and communications, and regional geology and physiography.

The Helmand River Basin is in southwestern Afghanistan and its principal river, the Helmand, heads just 200 km (120 mi) west of Kabul on the southern flank of the Koh-i-Baba and the western portion of the Paghman Mountains. It is bounded on the northwest by the Khosh and Farah River drainages, on the east by the Kabul, Matun and Marghe River drainages, and on the south by the Gumal and some unnamed streams which drain into rivers across the Pakistan Border. The location map showing these features is Figure 2-1.

The basin study area contains 139,800 km^2 (53,975 mi^2) with 22,245 km^2 (8,589 mi^2) non-contributing area. The non-contributing portion includes all of the Ghazni drainage 20,575 km^2 (7,944 mi^2) and an area of 1,670 km^2 (646 mi^2) at the extreme upper end of the Arghandab watershed. Contained within the basin are all or portions of Helmand, Kandahar, Bamyan, Ghor,

Kajiron

Kalat, Qalat

Kandahar, Khandahar, Qandahar

Kash River

Khanashin

Khosh, Khash, Khoosh, Khash

Khusk River

Koh-i-Baba

Kshi

Khusk-i-Nakhud, Kashk-i-Nakhud

Lal

Lashkar Gah, Lashkargah

L. Munda, Lui-Manda

Lora

Maisan

Malakhan

Margha River

Marja, Marjeh

Markhana

Matun River

Mazar-i-Sharif

Maydan, Maidan

Mokur, Mogur, Moqor, Moqur

Musa Qala, Mosa Kala, Musa Qalah, Musa Qaleh

Nad-i-Ali

Nowzad

Oruzgan, Orozgan, Urozgan

Paghman

Paktia

Palto River

Panjab, Panjao

Park River

Qala-i-Bost, Kala-i-Bost, Qala-i-Bist, Qala-i-Bust

Sang-i-Masha

Sangin, Sangine, Sanguin

Seraj

Shah Joi

Shamalan, Shamalon

Shinkai

Spin Bulda, Spin Buldom

Sulaiman Mountains

Tarnak

Tirin

Tirinkot, Tirin, Tirin Kot

Zabul

Zamindawar, Zamindaiwar, Zamin Dawar

CONVERSION FACTORS AND UNIT ABBREVIATIONS

To Convert	Into	Multiply by
Acre (ac)	Hectare (ha) or square hectometer (hm^2)	0.4047
	Square meters (m^2)	4,047
Acre-feet (ac-ft)	Megaliters (ml)	1.234
	Cubic Meters (m^3)	1,234
Celsius (C)	Fahrenheit (F)	1.8C + 32
Centimeters (cm)	Inches (in)	0.3937
Cubic feet/second (cfs)	Acre-feet per day (ac-ft/d)	1.984
	Acre-feet per year (ac-ft/yr)	724.0
	Gallons/minute (gpm)	448.0
	Cubic meters/second (m^3/s)	0.02832
	Liters/second (l/s)	28.2
Cubic meters (m^3)	Cubic feet (ft^3)	35.32
Cubic meters/second (m^3/s)	Cubic feet/second (cfs)	35.32
Cubic meters/square Kilometer (m^3/km^2)	Acre feet/square mile (ac-ft/mi^2)	21.0×10^{-4}
Fahrenheit (F)	Celsius (C)	(F^o-32) .5556
Feet (ft)	Kilometer (km)	3.048×10^{-4}
	Meter (m)	0.3048

CONVERSION FACTORS AND UNIT ABBREVIATIONS

To Convert	Into	Multiply by
Gallons/minute (gpm)	Cubic feet/second (cfs)	2.228×10^{-3}
	Liters/second (l/s)	0.06308
Hectares (ha)	Acres (ac)	2.471
Hectares (ha)	Square feet (ft^2)	$1,076 \times 10^5$
Inches (in)	Millimeters (mm)	25.4
Kilograms (kg)	Pounds (lb)	2.205
Kilograms (kg)	Megagrams (mg) or tonnes	1×10^{-3}
Kilometers (km)	Miles (mi)	0.6214
Liters/second (l/s)	Cubic feet/second (cfs)	0.03531
Megagrams (mg)	Tons (T)	1.103
Meters (m)	Feet (ft)	3.281
Meters/second (m/s)	Feet/second (ft/sec)	3.281
Megaliters (ml)	Acre-feet (ac-ft)	0.810
Miles (mi)	Kilometers (km)	1,609
Millimeters (mm)	Inches (in)	0.03937
Pounds (lb)	Kilograms (kg)	0.4536
Square kilometers (km^2)	Square miles (mi^2)	0.3861
	Acres (ac)	247.1
Square miles (mi^2)	Square Kilometers (km^2)	2.590
Tonnes	Tons (T)	1.103
	Pounds (lb)	2,205
Tons (T)	Kilograms (kg)	907.2
	Megagrams (Mg)	0.9072
	Tonnes	0.9072

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CHAPTER 1

INTRODUCTION

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ACKNOWLEDGEMENTS

The Soil and Water Survey of the Helmand River Basin could not have been accomplished in the short time allowed for the study without the excellent cooperation of the several organizations and many individuals involved. The United States Agency for International Development (USAID) sponsored study was carried out in cooperation with the Helmand-Arghandab Valley Authority (HAVA), and the Water and Power Authority (WAPA) of the Government of Afghanistan (GOA).

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The Study Team consisted of the following:

USAID - Orville F. Jones, Study Leader

William F. Mildner, Geologist

Richard H. Anderson, Soil Scientist

Glen L. Nielson, Agronomist/Soil Conservationist

Charles E. Bigler, Hydrologist

GOA - Abdul Khalig (Dawari), Engineer, Assistant General Engineering Division, Technical Department, HAVA

Abdullah Ghaznawi, Program Director, Operation and Maintenance Division, Technical Department, HAVA

Ahmad Zai, Head of Economics Section, Planning Division, Technical Department, HAVA

Mohammad Assif, Laboratory Director, Planning Division, Technical Department, HAVA

Obidullah Hotaki, Head of Soil Classification, Planning Division, Technical Department, HAVA

A. Qader, Geologist, Ground Water Division, Soil & Water Department, WAPA

Abdula Latif (Halimi), Land Classification Member, Planning Division, Technical Department, HAVA

Rahimullah, Land Classification Member, Planning Division, Technical Department, HAVA

Mohammad Akber (Osman), Member, Planning Division, Technical Department, HAVA

M. Qasem (Taheri), Geologist, Design Division, Planning Department, WAPA

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GEOGRAPHIC NAMES AND SPELLINGS

Names used in this report are from Afghanistan sources. As the study was made, it was discovered that names of places were spelled in various ways on maps and in reports. The first spelling shown in the following list is the one used throughout this report. Other spellings, where listed, are some of the variations discovered.

Afghanistan

Anar Joi

Arghandab

Arghestan, Arghastan, Arghistan

Baba Gi

Bamyan, Bamian, Bamiyan, Bam-i-yan

Boghra

Bolan

Chah-i-Anjir, Chah-e-Anjir

Chakhcharan

Darweshan, Darwishan

Dasht-i-Margo, Dash-i-Margo

Dehraout, Dehraoud

Deshoo, Dashu, Deh-shu, Deshiu, Deshu

Diluran, Dil-Aram

Dori, Dora, Dore, Dorie

Farah

Gardendiwal

Gardez, Gardeyz, Gardiz

Garmsell, Garm-Sayer

Gawargi

Ghazni

Ghizab, Ghizab, Ghizad

Ghor

Girishk, Gereshk, Grishk

Gumal River

Hari River

Helmand, Hilmand

Hindu Kush

Kabul

Kadani River

Kajakai, Kajaki

Kaj, Kij